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VHF

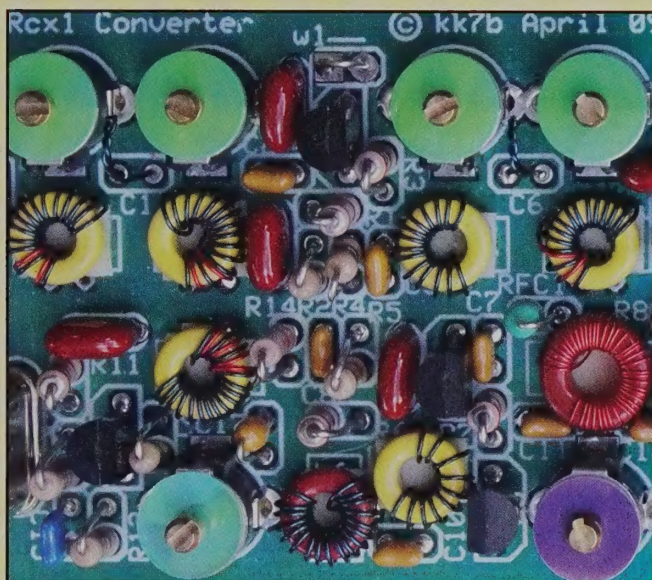
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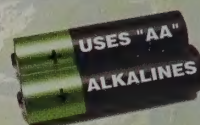


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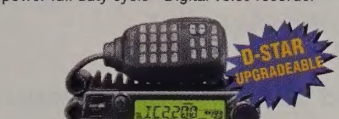
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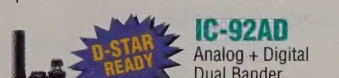
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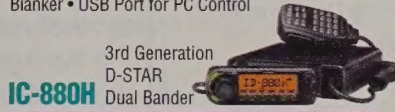
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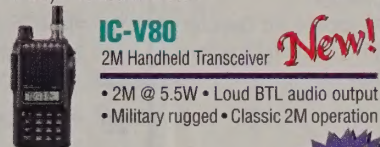
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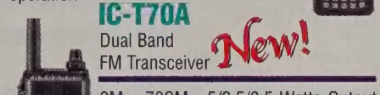
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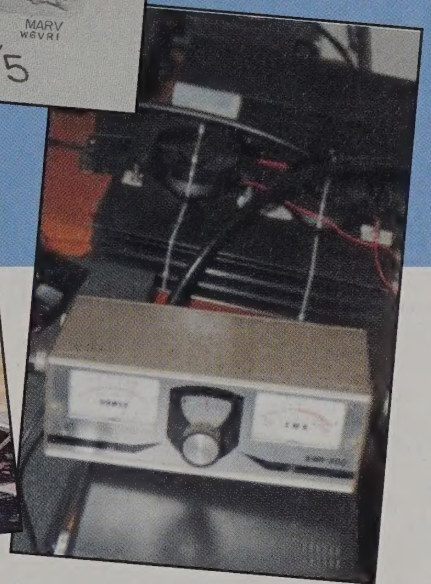
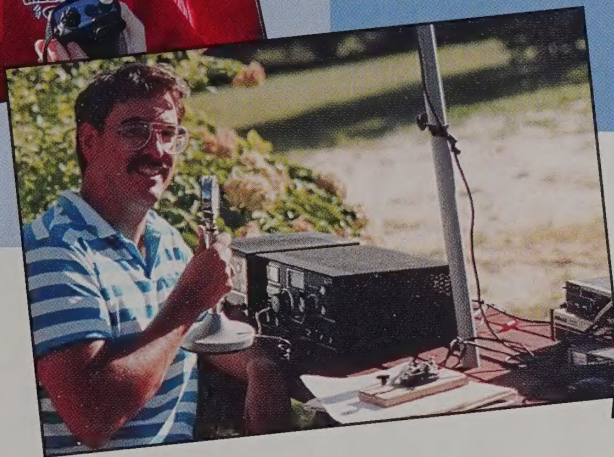
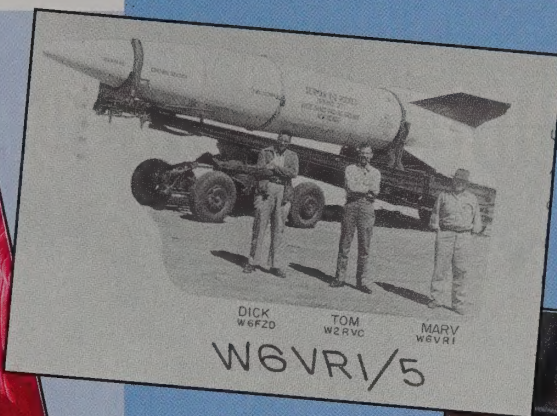
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LINE OF SIGHT

A Message from the Editor

Facing Facebook and Other Social Media

My thanks go to Propagation columnist Tomas Hood, NW7US, for bringing the CQ Communications family into the new age of social media. Tomas took the first initiative to develop fan pages on Facebook for each of CQ Communications' magazines, which, along with this publication, include the flagship, *CQ* magazine, *Popular Communications*, and *WorldRadio Online*.

Each of the publications has developed a growing fan base, with *CQ* magazine naturally leading the way. As of this writing *CQ* magazine has nearly 2500 fans; *Popular Communications* has over 300 fans; *WorldRadio Online* has nearly 500 fans; and *CQ VHF* brings up the rear with nearly 300 fans. In addition to *CQ* magazine's fan base, other independent CQ-related fan bases have started. They include the CQ WPX and CQ World-Wide DX Contests, which have nearly 700 and nearly 500 fans, respectively.

One of the ongoing complaints I hear about *CQ VHF* magazine is that it is published only four times a year. I feel that constraint every time I work on the next issue. I have to gauge what we publish relative to the piece's time value. Often I am presented with an item that, because of its relatively urgent time value being between publication dates, I cannot do anything with.

Here is an example: In early April I learned of the dates for the Spring Sprints. Unfortunately for the sponsors, the events were receiving little publication because news of the sprints was released well after all of the print media deadlines.

Enter Facebook: As soon as I learned of the dates I immediately created a post on the *CQ VHF* Quarterly Magazine fan page in which I made a brief announcement and created a link to the Southeast VHF Society's website. Facebook has now solved my problem for certain time-sensitive items such as a forthcoming contest, conference, grid-square activation, and/or band opening. Therefore, if you have a time-sensitive item that you want publicized to the world, post it on Facebook. If you have something that is related to our niche in the ham radio hobby, then post it on the *CQ VHF* Quarterly Magazine fan page. It will get instant dissemination to the nearly 300 fans who follow the magazine's posts.

The name of the game, however, is numbers. Rich Moseson, W2VU, the editor of *CQ* magazine, mentioned in his April 2010 editorial that *CQ* magazine had a presence on

Facebook. Almost overnight the fan base jumped from 1500 to over 2300. For *CQ VHF* magazine, every time I gain a new amateur radio friend I recommend to that person the *CQ VHF* Quarterly Magazine Facebook site. While *CQ VHF* is bringing up the rear in the count at this time, I expect that the publicity I am giving Facebook in this editorial will also give us a positive bounce in our number of fans. Are you a fan?

There are other social media outlets as well. Among them are Twitter and Skype. Thanks to the versatility of Facebook, when an administrator post is made to a fan page, it can be linked to automatically reflect on one's Twitter page. For me, this means that the nearly 300 fans on Facebook and my 60 or so followers on Twitter are getting the same message instantaneously. With the built-in link back tiny URL feature on Twitter my followers are linked to the full announcement on Facebook.

Skype is another source of social networking that is finding increasing use among ham radio operators. For example, for my May 2010 "VHF-Plus" column in *CQ* magazine I used both Facebook and Skype to interview Vu Trong Thu, XV9AA, in Hanoi, Vietnam. After Thu and I became friends on Facebook, I asked him for an interview via Skype, to which he readily agreed. Thu and I spent more than 40 minutes in a video conversation, covering a number of subjects. Be sure to take a look at the interview in my column.

As a late adopter, I am continuing to find so many of my ham radio friends have been using these social media tools for quite some time. For example, last fall one of the presentations made at the TAPR/DCC conference was done via Skype. Skype has so many potential applications. For example, someone's live balloon sat camera could be hooked to Skype so that people all over the internet could watch a live balloon launch.

Additionally, someone could conduct ham radio licensing classes in two or more locations—one live and the others via Skype. On a one-to-one basis, ham radio operators can collaborate with one another when designing or troubleshooting equipment.

While we at CQ Communications are in our infancy of adopting these social media tools, our universal initial reaction is: "Why haven't we been using these tools before now?" It seems that far from leading ham radio to its demise, the social media tools are starting to

contribute to the ongoing growth of the amateur radio hobby. Such growth caught the attention of Matt Sepic at NPR (National Public Radio). Matt wrote a very positive piece about amateur radio that elicited more than two dozen—almost universally positive—responses. Please see: <<http://www.npr.org/templates/story/story.php?storyId=125586086>> for the NPR story.

In his article, Sepic comments on the universal appeal of amateur radio, quoting a senior citizen and a high school youth. The senior, Helen Schlarman, WØAKI, commented: "[Ham radio is] a different community. There [are] no stereotypes of age; it's just talking and sharing and enjoying." Fifteen-year-old Jonathan Dunn, KDØHSL, stated that "Facebook and texting are fun, but making friends using a \$200 radio that doesn't come with monthly fees is more rewarding."

He added, "With ham radio you can talk to new people, all kinds of ages, races, and it's just amazing what a little radio can do. Because no matter where you are, if you have the right stuff and the right power you can talk to anyone."

CQ magazine Editor Moseson agrees with Schlarman and Dunn concerning the universal appeal of our hobby. In a comment to Dan Brown, a sociology student, concerning the social media's usefulness to the amateur radio hobby, Moseson wrote: "Online social media like Facebook help the traditional ham radio establishment reach out to younger hams (and potential hams) 'on their turf'."

No matter whose turf we are on, we hams are capable of benefiting from the new social media—if we use it right. There is one caveat, however, with social media: The bad guys are also reading our posts. Therefore, before you put down this editorial, get online with Facebook, and post, "I'll see you at Dayton," think twice about your vulnerable home and radios while you are away. Don't let those bad guys know that your new radio is now available for the taking while you're gone.

If you have some creative ideas for using the social media to further our niche of this, our wonderful hobby, please let me know. Thank you.

Out of respect for the social media outlets, I end my editorial with this salutation: Whether it's on Facebook, Twitter, or Skype, or here in the pages of this magazine—

Until next time . . .

73 de Joe, N6CL

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QUARTERLY CALENDAR OF EVENTS

Current Contests

June: ARRL June VHF QSO Party. The dates for this contest are 12–14 June. Complete rules are in the May issue of *QST*. Rules can also be found on the ARRL website (<http://www.arrl.org>). Many are making plans to activate rare grids. For the latest information on grid expeditions, check the VHF reflector (vhf@w6yx.stanford.edu) on the internet. For weeks in the run up to the contest postings are made on the VHF reflector announcing Rover operations and grid expeditions. It is a contest that will create for you plenty of opportunities to introduce the hobby to your friends who are not presently working the VHF-plus bands or are not hams.

SMIRK Contest: While no formal announcement exists on the SMIRK website (see below), it is assumed that because of prior years' announcements, the SMIRK 2010 QSO Party, sponsored by the Six Meter International Radio Klub, will be held from 0000 UTC June 19 until 2400 UTC June 20. This is a 6-meter-only contest. Exchange SMIRK number and grid square. Score 2 points per QSO with SMIRK members and 1 point per QSO with non-members. Multiply points times grid squares for final score. Awards are given for the top scorer in each ARRL section and country. For more information on filing logs, please see the club's URL at <http://www.smirk.org> and click on the SMIRK Contest link at the top of the page.

Field Day: ARRL's classic, Field Day, will be held on June 26–27. Complete rules for this contest can also be found in *QST* and at: <http://www.arrl.org>. In years past tremendous European openings have occurred on 6 meters. Also, as happened in 1998, tremendous sporadic-E openings can occur. This is one of the best club-related events to involve new people in the hobby.

CQWW VHF Contest: This year's CQ WW VHF Contest will be held between 1800 UTC July 17 and 2100 UTC July 18. A summary of rules is on page 67 in this issue, with complete rules in the June issue of *CQ* magazine and on the CQ website: www.cq-amateur-radio.com.

August: There are two important contests this month. The **ARRL UHF and Above Contest** is scheduled for August 7–8. Complete rules can be found in the July issue of *QST*. The first weekend of the **ARRL 10 GHz** and above cumulative contest is scheduled for August 21–22. The second weekend is September 18–19. Complete rules for this contest also can be found in the July issue of *QST* and on the ARRL's website.

Current Conferences and Conventions

May: Dayton Hamvention®. The Dayton Hamvention® will be held as usual at the Hara Arena in Dayton, Ohio, May 14–16. For details, go to: <http://www.hamvention.org>.

June: The annual **Ham-Com Hamfest** will be held June 11–12, in Plano, Texas. As always, the North Texas Microwave Society will present a microwave forum. For details, see the Ham-Com website: <http://www.hamcom.org>.

July: This year's **Central States VHF Society Conference** will be held July 22–24, in

Quarterly Calendar

The following is a list of important dates for EME enthusiasts:

May 6	Last quarter Moon and Moon apogee
May 14	New Moon
May 20	First quarter Moon
May 20	Moon perigee
May 27	Full Moon
June 3	Moon apogee
June 4	Last quarter Moon
June 12	New Moon
June 15	Moon perigee
June 19	First quarter Moon
June 26	Full Moon
July 1	Moon apogee
July 4	Last quarter Moon
July 11	New Moon; total eclipse of the sun
July 13	Moon perigee
July 18	First quarter Moon
July 26	Full Moon
July 28	Moon apogee
July 28	Southern Delta Aquarids meteor shower
August 3	Last quarter Moon
August 10	New Moon
August 10	Moon perigee
August 12	Perseids meteor shower
August 16	First quarter Moon
August 24	Full Moon
August 25	Moon apogee

—EME conditions courtesy W5LUU

Bridgeton, Missouri, at the Doubletree Hotel. For information go to: <http://www.csvhfs.org/>.

Calls for Papers

Calls for papers are issued in advance of forthcoming conferences either for presenters to be speakers, or for papers to be published in the conferences' *Proceedings*, or both. For more information, questions about format, media, hard-copy, e-mail, etc., please contact the person listed with the announcement. The following organizations or conference organizers have announced a call for papers for forthcoming conferences:

Central States VHF Society Conference: Technical papers are solicited for the 44th annual Central States VHF Society Conference to be held July 22–24 in Bridgeton, Missouri. Papers, presentations, and posters on all aspects of weak-signal VHF and above amateur radio are requested. You do not need to attend the conference, nor present your paper, to have it published in the *Proceedings*. Posters will be displayed during the two days of the conference. Please contact the folks below if you have any questions about the suitability of a topic. Strong editorial preference will be given to those papers that are written and formatted specifically for publication, rather than as visual presentation aids. Submissions may be made via the following: electronic formats (preferred); via e-mail; uploaded to a website for subsequent downloading; on media (3.5" floppy, CD, USB stick/thumb drive). Deadline for submissions: For the *Proceedings*, May 25; for presentations to be delivered at the conference, June 28; and for notifying them that you

will have a poster to be displayed at the conference, June 28. Bring your poster with you on July 22 or 23. Contact information: Ron Ochu, KO0Z@arrl.net.

Technical papers are solicited for presentation at the **29th Annual ARRL and TAPR Digital Communications Conference** to be held September 24–26 in Portland, Oregon and publication in the conference *Proceedings*. Presentation at the conference is not required for publication. Submission of papers is due by July 31 and should be submitted to: Maty Weinberg, KB1EIB, ARRL, 225 Main St., Newington, CT 06111, or via the internet to maty@arrl.org. For suitable topics and submission guidelines also contact Maty via e-mail and check <http://www.arrl.org>.

Meteor Showers

May minor showers include the following and their possible radio peaks: *η-Aquariids*, May 6; *ε-Arietids*, May 9, 0815 UTC; *May Arietids*, May 16, 0815 UTC; and *α-Cetids*, May 20, 0713 UTC.

June: Between June 3 and 11, the *Arietids* meteor shower will once again be evident. This is a daytime shower with the peak predicted to occur on June 7, around 1700 UTC. Activity from this shower will be evident for around eight days, centered on the peak. At its peak, you can expect around 60 meteors per hour traveling at a velocity of around 37 km/sec (23 miles per second).

On June 9 the *Zeta Perseids* is expected to peak around 1700 UTC. At its maximum, it produces around 40 meteors per hour. The *Boötids* is expected to make a showing between June 27 and July 2, with a predicted peak on June 27. On June 28 the *Beta Taurids* is expected to peak around 1600 UTC. Because it is a daytime shower, not much is known about the stream of activity. However, according to the book *Meteors* by Neil Bone, this and the *Arietids* are two of the more active *radio* showers of the year. Peak activity for this shower seems to favor a north-south path.

July: This month there are a number of minor showers. The *Piscis Austrinids* is expected to peak July 28. The *δ-Aquariids* is a southern latitude shower. It has produced in excess of 20 meteors per hour in the past. Its predicted peak is also around July 28. The *α-Capricornids* are expected to peak on July 30.

August: Beginning around July 17 and lasting until approximately August 24, you will see activity tied to the *Perseids* meteor shower. Its predicted peak is between August 12 at 2330 UTC and August 13 at 0200 UTC. The *κ-Cygnids* meteor shower is expected to peak on August 18. The visually-impossible *γ-Leonids* is expected to peak August 25, around 1600 UTC. However, this shower may have gone dormant. The *α-Aurigids* is expected to peak around September 1.

For more information on the above meteor shower predictions see Tomas Hood, NW7US's propagation column beginning on page 74. Also visit the International Meteor Organization's website: <http://www.imo.net/calendar/2010>. A pdf document of the year's meteor showers is available from the IMO at: <http://www.imo.net/docs/cal2010.pdf>.



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Activation of Elusive Grid EL58

This little elusive island that has one paw in the Gulf of Mexico and the other in the Mississippi River is almost nowhere to be found—except that it lies within a very rare grid square. If it's rare, then hams have to go there. Here WA4EWV tells the K5N EL58 activation story.

By Al Lee,* WA4EWV

The Fred Fish Memorial Award (FFMA) is given to any amateur radio operator who has worked all 488 Maidenhead grid squares in the 48 contiguous United States on 6 meters. (For details on the award go to: <<http://www.arrl.org/awards/ffma/>>.) One of the most wanted grids is EL58, which is located on an island on the very south-east tip of Louisiana with the Mississippi River on one side and the Gulf of Mexico on the other.

A Little History

There had only been one DXpedition to EL58, and that was in 1985. Various hams had talked about going there, but it wasn't until November 2008 when some serious discussions began to take place. Bill Musa, K5YG, and Marshall Williams, K5QE, started a series of discussions on the FFMA Yahoo Groups reflector. During that time frame, Danny Cristina, N5OMG, his son Daniel, KE5KDM, plus Bruce Brackin, N5SIX, and Al Lee, WA4EWV, joined the effort.

In December 2008 or January 2009, it was decided that a trip should be made to the area to scout it out. Obviously, winter was not the time to go. Many e-mails later and a two-hour Skype QSO laid out some very important plans.

The Planning

An operation of this type is not an easy task. It consisted of seven hams from four different states, so coordination was relatively difficult. Then there was the matter of getting a guide to help identify the best place to land. Danny,



Bruce Brackin, N5SIX, getting ready to transport equipment to the K5N location.

N5OMG, approached several guides before Capt. Shawn Lanier agreed to help with our project.

Bill, K5YG, took the leadership role, as he had been on many island expeditions. He would provide a spreadsheet in which all of the equipment could be listed and each member would know what he was to bring. Bill's leadership and past experience was invaluable. The use of the spreadsheet was an absolute necessity.

Danny, N5OMG, would man the 75-meter link to our pilot (land based) stations. He would also be the treasurer.

Bruce, N5SIX, was given the task of coordinating the station's radio equipment. I had had a lot of RV and traveling boat experiences, so I volunteered to prepare the menu and purchase the food.

Marshall, K5QE, would provide two 6-meter TE Systems amplifiers and power supplies for the stations.

In April, Danny, N5OMG, his son Daniel, KE5KDM, and Bill, K5YG, made the scouting trip. Pictures and videos were taken.

The special call, K5N, was applied for and approved. Joey, W5TFW (one of our pilot stations), offered to pay for the QSL cards via the "Six Club."

We also welcomed aboard our pilot stations: Joey Fiero, W5TFW, Tip Tipton, WA5UFH, and Tom Miller, AC5TM. Since there would be no internet service, they would monitor our operations using HF.

Bob Delaney, WN2E, then joined the group. Since he is a pharmacist, he

*7137 Dolphin Bay Blvd., Panama City Beach, FL 32407
e-mail: <wa4ewv@wa4ewv.net>



Some of the equipment laid out on the grass prior to setting up the stations.

became the group medic. We each filled out medical record cards along with emergency contact information. The contact information was left with each spouse—just in case. Danny, N5OMG, provided us with his SatPhone number—again for emergency use only.

Tip, WA5UFH, who is an avid HSMS (high-speed meteor scatter) ham and hosts the WSJT group site, volunteered to post anything necessary for the expedition; see <http://www.ykc.com/wa5ufh/>. “JD” Dupuy, NØIRS, set up a

section on his web page for us: http://www.kcvhfgridbandits.com/kc_vhf_grid_bandits_018.htm.

Daniel, KE5KDM (17 yrs old), volunteered to be the “camp fisherman.” He turned out to be a great fisherman, providing the camp with flounder, trout, and other treats from the sea.

Because of the large number of hams asking to donate to our trip, Danny set up a PayPal account for us. Originally, we had decided not to solicit donations. Expenses kept mounting, but we still

didn’t solicit. We just said, “Let your conscience be your guide.”

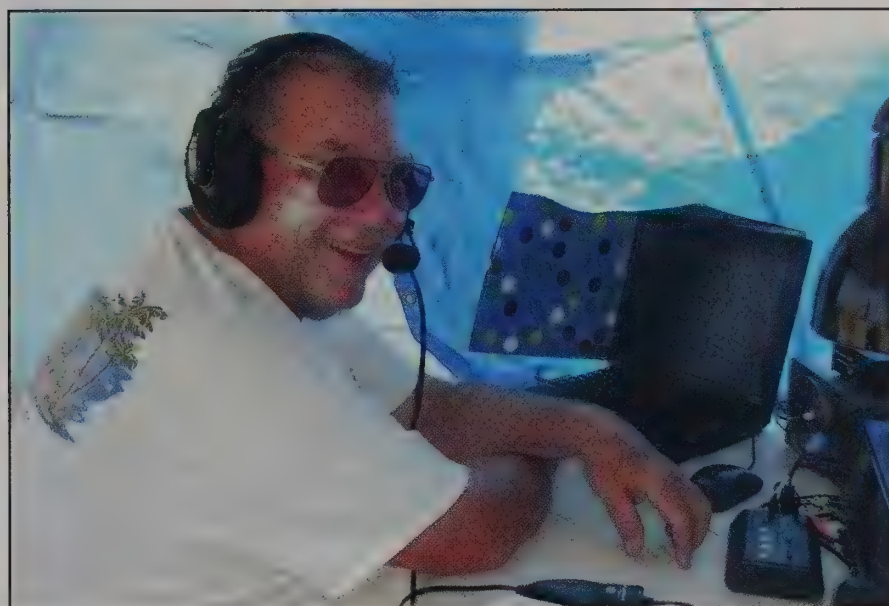
The Trip to Venice, Louisiana

May 28, 2009: The day finally arrived when we all headed for Venice, Louisiana, 65 miles south of New Orleans, and Capt. Lanier’s camp (see: <http://www.fishon-guideservice.com>). Al drove from Panama City Beach, Florida, pulling a Boston Whaler. He rendezvoused with Bill and Bob in Ocean Springs, Mississippi. Marshall drove from Hemphill, Texas, Bruce from Brandon, Mississippi, and finally Danny and Daniel from Harahan, Louisiana, towing their boat.

After our arriving and loading Capt. Lanier’s boat, he provided dinner of charcoal-grilled fish. The bunk room was a welcome sight after the long drives and loading the boat.

Getting to the Island

On Friday, May 29, 2009, before sunrise, we launched the three boats, and loaded Al’s and Danny’s with the remaining gear. The first part of the trip was down West Bay. The water was smooth and we were able to run at about 20 knots. Capt. Lanier knew the entire bay like the back of his hand, and we had no trouble with shallow areas. We saw several well



The author operating from one of the stations.



Bill Musa, K5YG, operating from one of the stations.

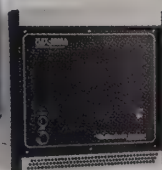
heads along the way. We then cut into the Mississippi River for five miles. This part of the trip was uneventful. However, we did pass one inbound ship. Capt. Lanier had already briefed us on the dangers of not only the stern wake, but the bow wake as well. We gave each of these as wide a berth as possible, and cut the wake at 90 degrees and slow speed. We then turned east into the cut toward the island.

The first order of business was Daniel and his weed whacker cutting a path through the thigh-high marsh grass over to the beach site. After we made our landing, each passing ship would "suck" a little water away from us, and then push it back with its wake. Since we were at least a mile away from the water, however, it presented no problem. It just sloshed water up into the path Daniel had cut through the tall grass. Ankle-deep muck is a good way to describe it.

The most grueling part of the morning was bringing all of the equipment from the landing area to the beach. The first tent erected was the common area where



All seven of the operators at K5N.



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An aerial photo of the EL58 site.

the food, cooking equipment, and chairs for relaxing were kept. This was followed by the installation of the generator and the power cords from it to where the operating tents would be set up. Erection of the two M² 6M5X Yagis, the Cushcraft R7 (on loan from K2FF), and the fan dipole inverted-V followed. The three operating stations were SSB/CW for 6 meters, meteor scatter for 6 meters, and HF for communications with our pilot stations. Sleeping tents and the toilet tent were the last to be set up. During the erection of the meteor-scatter Yagi it fell over, bending several elements and breaking off one completely. The bent ones were straightened as best we could, and the broken reflector element was taped on with electrical tape!

Environment

The only traces of any animals were deer tracks. We had prepared for the worst concerning bugs. We each had brought a ThemaCell and lots of spray repellent. Fortunately, the only bugs that came out were the ones that liked the Coleman lanterns we used in the common-area tent. No flies, no mosquitoes, no horse flies.

The weather was hot with not a cloud in the sky during the entire trip. We used plenty of SPF 50 on all exposed parts of our body. We also brought fans, which were a great help keeping us cool inside the operating tents.

On Saturday, Mike, WB5LLI, Keith, W5KB, and Charlie, WD5BJT did a fly-by and took photos from the aircraft.

Operating

With everything up and operating, the first 6-meter SSB QSO was made by Bill with K1WHS (2010 UTC on 50.150 MHz). Operations continued non-stop through Friday night, all day and all night Saturday, and ending just before 1700Z on Sunday with Al at the mic of the SSB station. At some point Daniel, who had been doing a lot of fishing and scouting the area, said that there was about 3 feet of water behind the spillway where we could bring our boats to load from a sandy beach area. This was a welcome revelation, as the thought of dragging everything back through the bush was not appealing! Those of us not operating started taking the camp apart and putting the equipment on the beach for loading.

Not only did the group work 6 meters, but many QSOs on HF were made, activating ARLHS USA 1101 under the "Visual Sight Rule" and a New Island—USi LA105S (Burwood Island, LA; South West Pass).

One of the highlights of the operation was the two EME contacts made by Al with Lance, W7GJ, and Mike, K6MYC. Those two were the first ever EME contacts from EL58! This was done with the damaged beam, too!

Problems Encountered

The erection of the meteor-scatter beam presented a problem when it fell over as were putting it up. The solution to prevent this from happening again is to use more manpower to erect one.

Another problem was the fact that the manufacturer of the generator had not connected the ground to the common. This could have presented a problem with switching power supplies. After removing the control panel and connecting the two together, all was well.

We had rotor failure on the meteor-scatter antenna. It was an old Radio Shack TV rotor that gave up the ghost after about 20 hours. Recommendation for future DXpeditions is a little higher quality rotor.

A note about the toilet: The one we purchased was okay, but not for use in the sand. One or more of the three legs would sink. Al found some small blocks of wood to put under the legs, but it didn't help that much. If the toilet has to be on sand, bring a piece of plywood at least a foot larger than the area of the three legs.

Operating Notes

During the QSOs most stations thanked us and said 73. There were a lot of stations on SSB that wanted to rag-chew. It was quite tempting, but good operating practice by our operators kept that to a minimum, giving other stations a chance.

Summary of our QSOs:

6 meters SSB and CW = 424
6 meters HSMS = 56
6 meters EME = 2
Total 6 meters = 482

HF:
 17 meters = 35
 20 meters = 45
 40 meters = 36
 75 meters = 43
 Total HF = 159

States worked = 40
 Unique grids worked = 118

Sights and Things to Remember

The fishing camp at Capt. Lanier's was very nice. There were two simple bunk rooms with four bunks each. They were air-conditioned and comfortable. His fish dinner was one to remember!

The marina in Venice has made what looks like a 100% comeback after Hurricane Katrina. That was a pleasure to see.

We had three boats—those of Capt. Lanier, Danny, and Al. Each was loaded to its maximum weight capacity. We had to be careful in that regard to not overload any of them. Part of the spreadsheet planning was to weigh everything we were bringing and eliminate things that were either duplicated or just too heavy.

As can be imagined, food and fluid intake were an important part of the trip. We cooked hamburgers on the grill, fried fish that Daniel caught, and had sandwich meat, peanut butter and jelly, cheese crackers, and cookies. Last of all, we consumed several Meals-Ready-to-Eat (MREs). One of the things that Danny did was bring a large cooler with block ice topped with dry ice. It lasted all weekend, resupplying the drink and food coolers with ice. Water and Gatorade sustained us. Cola drinks just don't hack it, although many were consumed.

Summary

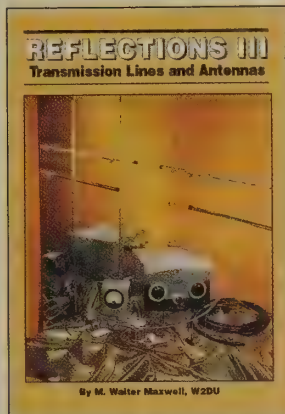
The six "P"s come into play when an adventure such as this: "Prior Planning Prevents Pee Poor Performance." Knowing every aspect of the operation is the key to success. Every contingency should be taken into consideration. Everything from tool boxes, to equipment, to health considerations must be taken into account. Fuel and oil for the generators was a major weight consideration. (We even had a spare generator.) In our particular case, if someone had been seriously injured, either a one-hour trip back to Venice (then 65 miles to New Orleans) or helicopter evacuation would have been necessary.

It can be said that the seven of us worked well together as a team, and we made new friends to boot.

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by Walter Maxwell, W2DU

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Amateur Radio and the Cosmos

Part 4 – Never a Dull Moment

Nowadays we take satellites for granted. Yet how far have we come? At the beginning of satellite development, hams played significant roles. Here WA2VVA details some of the hams and their roles during those early days.

By Mark Morrison,* WA2VVA

The signs around campus said it all. On April 22, 1975 the world's leading rocket scientist would visit this town in upstate New York to present a lecture on the uses of space—not just any scientist, mind you, but Wernher von Braun! The man whose Saturn V rocket took man to the moon in 1969 and whose Redstone rocket put America's first satellite into orbit in 1958. The man whose visions of space travel were captured on the pages of *Collier's* magazine, the films of Walt Disney, and even Disneyland itself, leaving lasting impressions for generations of future scientists.

In his lecture “The Uses of Space, A \$100 Billion Dollar Gamble; Is the Earth Winning?” (see figure 1) von Braun described his newest vision for space—the use of satellites to provide television programming to remote areas of the world, not for entertainment, but for medical and educational purposes. This was something with real merit, as it would benefit those intended to receive such broadcasts as well as the men and women to follow in von Braun's footsteps. After all, putting rockets into space wasn't something you learned in college. You learned it from those who came before you. However, for me, what followed the lecture was of greater significance.

A reception was held for von Braun at a prominent fraternity where perhaps twelve of us were waiting for him to make his way over from the lecture hall. I don't think anyone knew what to expect. After all, we were about to meet Wernher von Braun, a legend in his own time. When the time finally arrived, we were imme-

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Figure 1. The promotional piece for Wernher von Braun's 1975 lecture describing his newest vision for space.

diately impressed by the friendly persona of this big man as *he* greeted us!

At that time von Braun was something of an ambassador for the space program and perhaps a bit worried about it all. The great achievements in space had already been recorded in the history books. Man had walked on the moon several times, satellites were parked in geostationary orbits, and space probes were on their way to the planets and beyond. What would happen in the future depended on the U.S. government, and with support for future moon missions waning, something had to be done.

Curiously, von Braun wasn't the only space ambassador of the 20th century. Concerned about the future of aeronautics, in 1930 aviator Charles Lindbergh

took interest in the rocket work of Clark University professor Robert H. Goddard. Impressed by what he saw, Lindbergh recommended Goddard to financier Daniel Guggenheim, who awarded him a \$50,000 grant and convinced him to move to Mescalera Ranch, near Roswell, New Mexico. This allowed Goddard to experiment with much larger rockets, without the prying eyes of the local fire marshall or even the press.

It is interesting to note that Goddard was a radio amateur of sorts, having organized the Wireless Club at Clark University in 1927, the same year that Lindbergh crossed the Atlantic solo and, coincidentally, von Braun's German Rocket Society was formed. Goddard held several radio-related patents, many

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R. H. GODDARD.

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APPLICATION FILED AUG. 1, 1912.

1,159,209.

Patented Nov. 2, 1915.

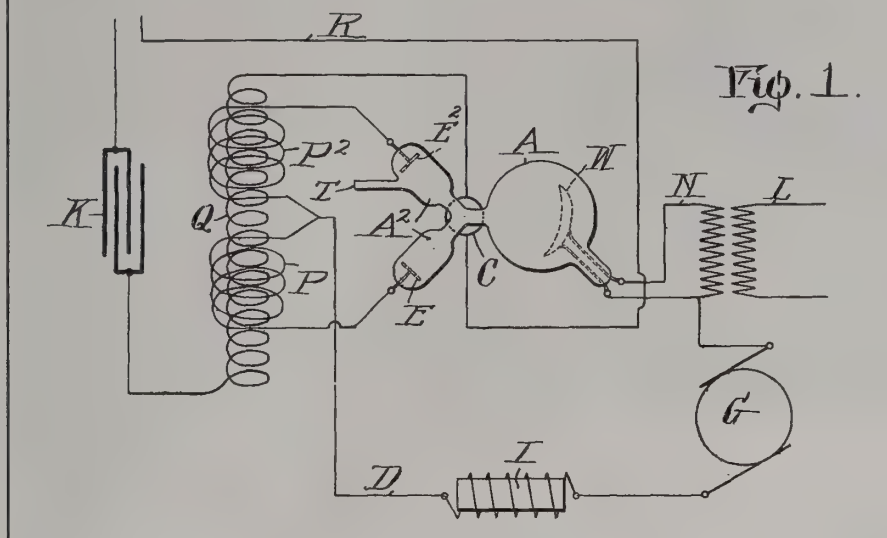


Figure 2. One of Robert H. Goddard's patents, issued in 1912, was for a vacuum-tube oscillator.

of which he sold to Westinghouse in these, the earliest days of radio broadcasting. One of Goddard's patents was a vacuum-tube oscillator for which he filed a patent application in 1912 as shown in figure 2. Note that this work actually preceded similar work by radio pioneers de Forest and Armstrong!

This particular patent, which was used in the Collins 45A transmitter, would later involve Goddard in a patent infringement lawsuit between RCA and Collins Radio. Art Collins (WØCXX, ex-9CXX) personally contacted Goddard for assistance in defending his design. Although Collins would lose the suit, a subsequent appeal would lead to a generous licensing agreement with RCA that allowed his young company to flourish.

Goddard's move to New Mexico was preceded by that of an older cousin, Ralph W. Goddard, who held the call 5ZJ. Ralph moved to New Mexico in 1914, where he became Dean of Engineering at New Mexico College of Agriculture and Mechanical Arts. Sadly, Ralph died shortly before Robert's arrival.

The financing of Daniel Guggenheim, coupled with the wide-open spaces of New Mexico, gave Robert Goddard unparalleled opportunity to follow his elusive dream of building rockets to probe the edge of space. That dream would be cut

short, however, when the Navy asked for Goddard's assistance in developing Jet Assisted Take Off rockets, otherwise known as JATO, in Maryland. Curiously, parallel work would be done by Reaction Motors in New Jersey, and another Guggenheim beneficiary, the Guggenheim Aeronautic Laboratory of the California Institute of Technology, also known as Caltech. The Caltech effort would result in the first commercial JATO units, as well as the now famous Jet Propulsion Laboratory (JPL).

A New Era in Rockets

Following Goddard's departure from New Mexico, a new era in rocket development would begin just 100 miles to the west of Roswell. This barren stretch of desert, bordered on two sides by mountain ranges, rail facilities to the south, and a lone highway that separated the firing area from the impact area, would become the White Sands Proving Grounds. At the end of World War II, the United States had acquired a large stock of V-2 missile components from Germany. These parts were shipped by rail to Las Cruces, New Mexico and then transferred to White Sands for use in high-altitude research. Also transferred were Wernher von Braun and several of his top scientists.

Over the next few years General Electric, Johns Hopkins, the Naval Research Laboratory (NRL), Caltech, Douglas Aircraft, and Bell Laboratories all would be involved in rocket programs here. While most concerned high-altitude research, some were military projects.

As might be expected with so many technical people all in one place, a large number of amateur radio operators would also live here. One was Philip H. Smith, 1ANB, who worked on radar antennas for Bell Laboratories. Smith is perhaps best recognized for his "Smith Chart" known to engineers and radio amateurs the world over.

Another was Richard Tousey, of the NRL, who scored one of the first scientific successes at White Sands. By loading 35-mm film into the nose cone of a V-2 rocket, along with a special type of spectroscope, Tousey recorded the first spectrographs of the sun in the ultraviolet. Tousey's involvement with amateur radio dates back to 1920, when at the age of 12 he was thought to be the youngest ham in the city of Boston.

Yet another ham was Curtis LeMay (DL4AFE, and later, KØGRL, K4FRA, K3JUY, W6EZV), then Deputy Chief of the Air Staff for Research and Development. Following World War II, LeMay commissioned Douglas Aircraft to study the problem of putting a satellite into orbit as part of Project RAND and gave them just three weeks to do it. Amazingly, the official RAND report, entitled "Preliminary Design of an Experimental World-Circling Spaceship," was released just two days before the deadline. This classic text is available as a free download from the RAND website (<http://www.rand.org>).

Figure 3 shows three other hams, all working at White Sands in 1947. From left to right are Dick Mockbee, W6FZD, Tom Bohnsack, W2RVC, and Marv Olson, W6VRI. This QSL card, supplied through the courtesy of Steve Durst, documents a QSO between W6VRI and W8RM on September 23, 1947. As Steve points out, the postage for this QSL card was cancelled the same day that Johns Hopkins launched the first Aerobee rocket. An interesting account of the Aerobee rocket can be found at Steve's website at <http://www.collectspace.com/ubb/Forum20/HTML/000588.html>.

When this photo was taken, Mockbee was involved with field testing of the NIKE missile for Douglas Aircraft, a major sub-contractor to Bell Labs at the

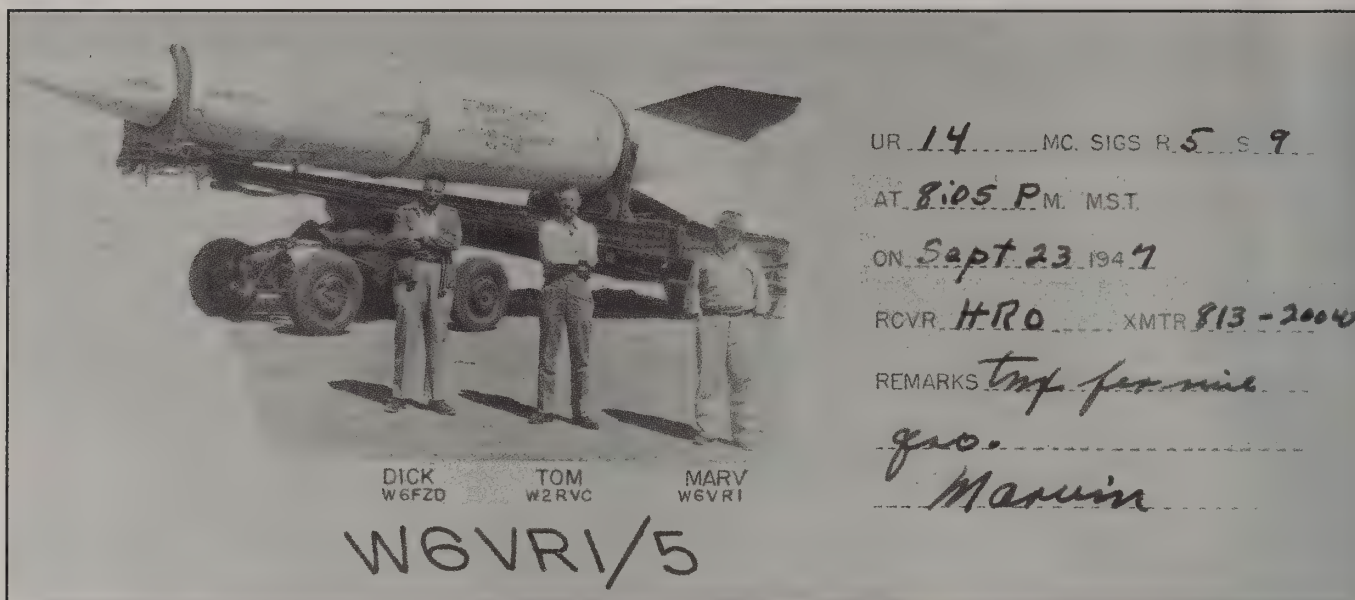


Figure 3. The White Sands Proving Grounds in New Mexico was the site of a new era in rocket development. A large number of amateur radio operators worked there in 1947, including the three shown on this QSL card (from left to right): Dick Mockbee, W6FZD, Tom Bohnsack, W2RVC, and Marv Olson, W6VRI. This QSL card, supplied through the courtesy of Steve Durst, documents a QSO between W6VRI and W8RM on September 23, 1947.

time. In 1948 he officially moved over to Project RAND, becoming one of the earliest technical people in what would later become the RAND Corporation. It is interesting to note that although much of Mockbee's work involved early computers, in 1964 he worked on a technical feasibility paper for the construction of an all digital, microwave relay system for use in the distributed network proposal of Paul Baran. This work, elements of which would later appear in the modern internet, is perhaps the first reference to a wireless internet node. A full description of this microwave design can be found at the RAND website (http://www.rand.org/pubs/research_memo-randa/RM3762/RM3762.chap6.html), including the article "Experimental Transceiver for 5650 Mc," by C. J., Prechtel, W8DRR, which appeared in the August 1960 issue of *QST* (Vol. 44) on pages 11–15. (Editor's note: A copy of Prechtel's article is available to ARRL members under the "Members Only" section of the League's website: <http://www.arrl.org/members-only/>.)

The Aerobee rocket was the high-altitude research project of Johns Hopkins and involved Dr. James Van Allen, who himself had pioneered one of the biggest issues with high-altitude research—getting instruments to higher altitudes for longer periods of time. His solution was something called the Rockoon, a combination of rocket and balloon. By lifting the rocket to a higher altitude before igniting it, the rocket would not waste valuable fuel pushing through the lower and denser parts of the atmosphere.

One problem with high-altitude rocket research was that several launches were often necessary in order to collect any meaningful amount of data, not to mention the fact that prior to the use of telemetry, instrumentation packages would simply crash into the impact area, where they had to be located before any data could be retrieved. Much better would be a platform that stayed aloft, such as an orbiting satellite. According to Space writer Willey Ley (in his classic book *Rockets, Missiles, &*

Space Travel, ca. 1953), it was the development of telemetry in the general timeframe of the late 1950s that actually made the idea of an orbiting satellite a practical possibility. All that was needed was a means of putting one into space. Although Goddard did not live to see it, in 1949 a modified V-2 would boost a Caltech WAC Corporal to the edge of space, setting a new world altitude record. However, there were other rockets, too. A Navy research rocket named Viking would set a world altitude record for a single stage of 210 km on August 7, 1951. Furthermore, years later Viking would be favored to launch America's first satellite.

Rocket Launches

When America first proposed putting a satellite into orbit as part of the International Geophysical Year (IGY) of 1957–1958, there were several rocket candidates: the Army's Redstone, a direct descendent of von Braun's V-2; the Air Force's Atlas; and the Navy's Viking. The first two were ballistic missiles, whereas the Viking was a true research rocket. Since the IGY was to be a peaceful mission, President Eisenhower gave the job of launching America's first satellite to the Viking team and their Vanguard satellite.

Not being a military project, progress of the Viking rocket and its Vanguard satellite became regular news items. During the IGY the American Museum-Hayden Planetarium in New York City dedicated Viking Hall and published regular accounts of Vanguard's progress in its official monthly bulletin called "The Sky Reporter." The January 1957 issue showed a see-through picture of the Vanguard satellite on its cover and continued to report on it in subsequent issues.

When the Soviet Union launched Sputnik I in October of 1957 "The Sky Reporter" held fast, continuing to publish reports of the Vanguard program even though by this time von Braun had been authorized to launch a different satellite,

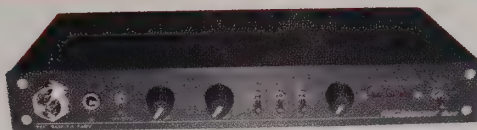
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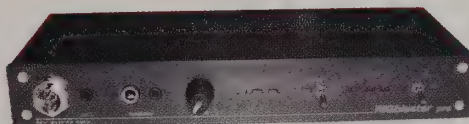
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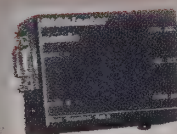
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Explorer I, using a Redstone variant known as the Jupiter-C. It is interesting to note that Dr. James Van Allen, the same man who oversaw many rocket launches from White Sands, equipped Explorer I with instruments that would make the greatest discovery of the IGY—the radiation belts later named in his honor. On January 31, 1958 Explorer I was launched from Patrick Air Force Base into a polar orbit, thus becoming the first orbiting satellite launched by the United States.

Later that same year amateur radio operators would be called back to White Sands, this time as part of Operation Smoke Puff. The idea was to launch a rocket into the upper atmosphere and release a cloud of potassium ions known to reflect radio signals. Amateurs would then attempt to communicate by bouncing their signals off this cloud. By studying amateurs' reports it would then be possible to study the upper atmosphere in a uniquely different way. Michael Gladych authored an interesting account of this event, complete with illustrations, his article was published in the October 1958 issue of *Popular Mechanics*.

Advances in Technology

The early satellites may have solved the time-aloft problem, but they brought a new limitation—limited battery power. Fortunately, the rise of rocket power in the late 1950s was paralleled by advances that were beneficial to spacecraft, including the transistor, the silicon solar cell, and the traveling wave tube amplifier (TWT), all inventions associated with Bell Labs in Murray Hill, New Jersey. It is interesting to note that Vanguard was the first satellite to be powered using silicon solar cells.

The TWT was actually invented by Austrian-born radio experimenter Rudolph Kompfner, who first wrote of his invention in the same British magazine that Arthur C. Clarke proposed the synchronous satellite orbit—*Wireless World*. Recognizing the potential of Kompfner's invention, J. R. Pierce, then Executive Director of Electronics Research at Bell Labs, recruited Kompfner to serve as his Director. Kompfner accepted this position, and another engineer, C. Chapin Cutler, W1TX, would serve as Assistant Director. Cutler was an early member of the wireless club at Worcester Polytechnic Institute, which claims to be the first operational radio club. Together, Pierce, Kompfner, and Cutler would exert great

influence on the development of communications satellites and the concept of radio repeaters in space.

Project Echo and Telstar

Kompfner later would be responsible for building the East Coast station for Project Echo at Crawford Hill, which involved many other amateur radio enthusiasts. One was Bill Legg, W2VE (ex-W2IPJ), who worked at Crawford Hill with Dick Turrin, W2IMU, during the early days of Echo and Telstar. In a recent e-mail to this author, Bill mentioned how he operated the tracking part of the program. Dick worked on the phase-lock tracking receiver.

In a 1963 lecture at Oxford, Pierce described how orbital elements were computed at NASA's Goddard facility in Greenbelt, Maryland and then transmitted to Crawford Hill and Goldstone via teletype. The punched tapes were then loaded into digital to analog converters that, at the appointed time, would keep the antennas pointed at the satellites passing overhead.

For an interesting look at the many other amateurs involved with this project, refer to a photo collection entitled "Hams in the Telstar Project" that appeared on page 64 in the May 1963 issue of *QST*. (Editor's note: This article is also available to ARRL members at: <http://www.arrl.org/members-only/>.) Among the hams pictured in the piece are: Joseph Olekniche, WB2EYM; Lewis Lowry, ex-KN2KEK; Bill Schober, W2JIM; Bruce McLeod, K2QXW; Frank Witt, K2TOP; John Galney, W2LCO; Ronald Wells, W1WSV; Leonard Dryer, W1DCC; Eddie Snyder, K1YFA; Kenneth Field, K1LSC; Rodney Rouse, K2LVE; John Jacobsen, W1VXD; Gerald DeBonis, W1YWF; and Robert Brandt, W2CQB. The photos were supplied to the League by W2NJR.

With the success of Project Echo, all manner of spacecraft would quickly follow. There would be communications satellites that transmitted messages from one part of the Earth to another. There would be meteorological satellites that monitored the Earth's weather. There would be satellites filled with instrumentation to monitor various properties of the Earth. Additionally, there would be general-purpose satellites, known as Application Technology Satellites (ATS), which served as platforms for many different applications. JPL, already well

established with its Earth and lunar probes, would develop new probes to explore the solar system, with names such as Ranger, Mariner, and Viking. Not to be outdone, a group of California radio amateurs would develop their own satellite known as Orbiting Satellite Carrying Amateur Radio, or simply OSCAR.

Amateur Satellites: Project OSCAR

The story of the first amateur satellite started in April 1959 when Don Stoner, W6TNS, then Semiconductor Editor for *CQ* magazine, published his design for a 50-mW, 2-meter transmitter he had successfully tested across the San Bernardino Mountains of California. Covering a distance of 120 miles with such a "tiny transmitter," Don realized it should work just as well 120 miles in a vertical direction, as in a satellite. In his article he joked, "Does anyone have a spare rocket for orbiting purposes?" (Editor's note: This article is available for download for a fee from <http://www.hamcall.net>.) As it turns out, an employee at Lockheed named Fred Hicks, W6EJU, read the article and believed it might be possible to find a launch vehicle through his association with the Air Force. After discussing this with Don, Project OSCAR was formed by a group of amateurs living in the San Francisco Bay area. After meeting with ARRL Southwest Division Director Ray Meyers, W6MLZ, and the head of JPL's Space Instrumentation System, Dr. Henry L. Richter, W6VZA, a plan was developed for the first amateur satellite.

Project OSCAR would eventually develop into a real group effort including not only Don and Fred, but other well-known hams, too. Included in the early OSCARs were Hank Brown, W6HB; Bill Orr, W6SAI; George Jacobs, W3ASK; Nick Marshall, W6OLO; Chuck Townes, K6LFH; Lance Ginner, K6GSJ; and many others, including our very own Dr. SETI, Dr. Paul Shuch, N6TX. Taking OSCAR from concept to reality also involved help from the ARRL and permission from the FCC, but in December of 1961 it finally did happen. This was followed by another beacon satellite (OSCAR 2) on June 2, 1962, and the first two-way amateur communications satellite (OSCAR 3) in March of 1965.

When AMSAT was formed to continue the work of Project OSCAR, Leonard Jaffe, K3NVS, formally announced to the

world that OSCAR 5 would indeed be launched. Jaffe was NASA's Director of Communications, already experienced with projects such as Echo, Telstar, ATS, and CTS, to name just a few. Obviously, OSCAR involved many people, in fact too many to mention, and the story has since evolved into an international affair that continues to this day.

The Satellites An Overview

To put things into perspective, the first six active communications satellites were Score, Courier, OSCAR, Telstar, Relay, and Syncom, in that order. Score was put into orbit on December 18, 1958 by the Advance Research Projects Agency (ARPA) and is remembered for transmitting a taped holiday greeting from President Eisenhower. Score was a delayed repeater-type satellite, allowing messages to be uploaded from one ground station and downloaded later to another. Courier was launched by the U.S. Army in September of 1960, and it too was a delayed repeater type. A major communications obstacle for this type satellite was the communications delay, which could be as long as two hours. Oscar was launched on December 12, 1961. It transmitted the word "HI" using Morse code on the 2-meter band. The repetition rate of this message was proportional to the satellite temperature, perhaps qualifying it as one of the earliest space probes. Telstar, the creation of AT&T and Bell Labs, was launched on July 10, 1962 and is probably the best known of the early satellites. AT&T funded its entire development and even refunded NASA for putting it into orbit. Relay, a NASA satellite, was launched on December 13, 1962 and is known for carrying the news of President Kennedy's death to the world. Syncom, another NASA satellite, was launched on February 14, 1963. Syncom 3 would become the first satellite to truly follow a synchronous orbit, and in 1964 was used to relay the first live TV pictures, of the Tokyo Olympic Games.

As it turns out, two radio amateurs working for Hughes Aircraft, Harold Rosen (call unknown) and Tom Hudspeth, W6LHN, played a major role in Syncom 3. Rosen and Hudspeth visited the Bell Labs Holmdel facility in 1960, apparently trying to sell their idea of a geostationary satellite. Pierce didn't think much of it at first, because at such a distance (22,300 miles) the communications delay would be objectionable to users of the phone system. However, Bell's concept of maintaining a fleet of orbiting satellites brought the unwieldy task of accurately tracking all those satellites. This would not be a problem for a synchronous satellite, and Pierce later commented about Rosen's genius. Of course, the Syncom satellite was the precursor to the vast majority of satellites in use today.

Another Hughes satellite with connections to amateur radio was ATS-1, an Application Technology Satellite. This satellite was launched in 1966 and used for geosynchronous and spin stabilization experiments until 1969, when NASA made it available for other uses. One use was proposed by Dr. John Bystrom of the University of Hawaii. He proposed the satellite be used as a relay for voice and data communications in the remote islands of the South Pacific. Well-known amateur Katashi Nose, KH6IJ, would take on the responsibility of developing the low-cost ground stations for use with this so called "Peacesat."

When Wernher von Braun retired from NASA in 1972, the year of the last moon landing, he went to work for Fairchild

Industries. While at Fairchild he pursued a new vision for space—not the space stations and interplanetary travel of the 1950s, but the use of satellites for the good of mankind. The idea was to adapt ATS satellites to provide direct television programming to remote areas of the world, not for entertainment, but for medical and educational purposes. Places such as India, Alaska, and the Appalachian Mountains all would benefit from this endeavor. The satellite of choice would be the Fairchild built AT-6, which von Braun promoted on campuses across the United States in the mid-1970s, which brings us back to where we started in this article.

Conclusion

As we sat down with Dr. von Braun, someone brought out a plate full of donuts, not the neat kind, but those of the messy white-powdered variety. As von Braun reached out for one, someone began the questioning by saying something like "Dr. von Braun, you've pretty much seen it all, from the early days of rocket development, to White Sands, all the way to landing a man on the moon. Looking back, how would you summarize your experience?"

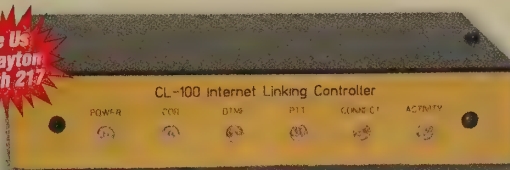
As the white powder fell from his doughnut, landing gently on his finely woven slacks, von Braun paused for a moment and said, "Well, there was never a dull moment!" All at once we felt at ease with this man, no longer worried what to say or how to act. We just sat there enjoying his company, as well as the donuts!

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“Ham-Tested” at Quartzfest

It's the primitive location. It's the fun and camaraderie. If you're a ham and own an RV, then it's the place to be—Quartzfest. Maybe it's the ruggedness that brings out the aspiring ham radio product developers to have their latest goodies field tested. Here WB6NOA describes several new products for the rugged ham radio operator.

By Gordon West,* WB6NOA

Plenty of weak-signal operators can be found at Quartzfest. This is the gathering of ham radio RVers five miles south of Quartzsite, Arizona during the annual Quartzsite RV show. Hams at Quartzfest join up at mile marker 99 and spend a week boon-docking on the desert floor. As hams, we are self-sufficient, and we don't need the customary campground hookups. After all, we have our own! (See: <<http://www.Quartzfest.org>>.)

Solar Charger with a Spike

Before the big rain storm moved in near the end of the encampment we had great sunny weather—perfect for “ham testing” solar panels. However, for those campers who hadn't “exercised” their on-board battery systems, many found that their house batteries just wouldn't hold a sun-charge as when they were new. It was a common problem, likely plate sulfation when hooked in to winter months of shore power at the RV storage facility.

After a year of testing PulseTech Products Corporation battery charging systems (photo 1), I was surprised that their pulse charging waveform could actually make a difference for several five-year old lead-acid batteries. (See the PulseTech Xtreme Charge at: <<http://www.XtremeCharge.com>>.)

“We use pulse current as an effective conditioning and breakdown of sulfation into active electrolyte, with this activity resulting in availability of active plate material and renewed performance and



Photo 1. PulseTech Xtreme Charge Marine version.

rechargeability in lead acid batteries,” comments John Wise, the engineer for PulseTech products.

“Our products deliver a 1-microsecond rise-time pulse, with a width of 12 microseconds, at a pulse frequency of 26 kHz to 34 kHz, with some products having a pulse current amplitude of 200 mA,” adds Wise. Therefore, besides charging a battery from the company's AC pulse charger, or several models of solar-panel pulse chargers, these pulses help to desulfate battery plates.

“Battery resistance is three to four orders of magnitude higher than the source resistance of the solar panel. Therefore, desulfating pulse performance is easier to measure as a current pulse, rather than a voltage pulse. The charge of the battery is not a pulse charge.

Our unique technology is a desulfating high-frequency pulse combined with smart charging,” adds Wise, describing how the product technically works. See the oscilloscope plot measured using a Fluke 199C scope meter and a Fluke I30s AC/DC current clamp. I used .1- to .5-ohm resistors for this measurement.

In the Dune Buggy that was towed to Quartzfest, a relatively old battery continued to function well on starting, likely due to this pulse technology. although the Buggy's solar panel could only generate a couple of hundred milliamps, evidently the pulse technology helped clean up a relatively sluggish battery.

In a marine installation, we ran the five-stage maintenance charger from PulseTech Products Corporation, model XC-100-W, and besides five stages of bat-

*CQ VHF Features Editor, 2414 College Dr., Costa Mesa, CA 92626
e-mail: <wb6noa@cq-vhf.com>

after a year a relatively older battery was now behaving like a youngster!

Your contact at PulseTech Products Corporation for more information is Smokey White at <SWhite@PulseTech.net>, or you can look up the company's claims and some technical details at <<http://www.XTREMECharge.com>>. You can also get pricing plus availability from dealers at this same website. To contact the head engineer, call 800-580-7554, ext. 159, for John Wise, who really knows his stuff. The general toll free-phone number is 800-580-7554, ext. 170.

MP Antenna Test

Another product we “ham-tested” at Quartzfest was a strange antenna system from MP Antenna Ltd. (see: <<http://www.MPAntenna.com>>). Several years ago I purchased one from Fred at Universal Radio that covers 25 MHz to 1.3 GHz receive, and 144, 222, and 440 MHz for transmit. Back then it was called the NilJon, but today it is model Ant-0865 Super-M Classic Mobile (photo 3). It terminates to an NMO connection and features three whips, different lengths, coming out at different angles for MultiPolarized radiation. Say what?

Dr. Nilsson, MP Antenna's inventor and research scientist, explained that patented MultiPolarized antenna technology improves weak-signal reception by its special phasing of the antenna elements. I could see an improvement over picket fencing, as he tells me one element will hold the signal as the other element may be in a momentary 3-dB fade. He indicated that MultiPolarized technology is very useful in downtown areas where multipath is always a problem for VHF/UHF mobile operation. The polarization, for us weak-signal users, is horizontal, but the capability of capturing vertically polarized signals that might otherwise be out of phase is dramatically improved by the multiple antenna elements.

At Quartzsite, we wanted to see how much better MP Antenna's 2.4-GHz antennas might do over a conventional 2.4-GHz WiFi Yagi (see photo 4). The Trident 2.4-GHz WiFi antenna, model Ant 0874, can operate omni, but add the Sector 60, 2.4-GHz directional 60-degree corner reflector (photo 5) with Ant 0868 for a substantial boost in gain over the omni—12 dBi as plotted, about the same as our cumbersome 2.4-GHz Yagi.

Side by side, the MP Sector 60, 2.4-GHz multi-polarized high-gain corner reflector



Photo 4. How will a conventional 2.4-GHz WiFi antenna compare with MP Antenna's Sector 60, 2.4-GHz antenna?

directional antenna beat the daylights out of the conventional 2.4-GHz fiberglass-enclosed Yagi! I was able to land distant WiFi hotspots out in the desert, thanks to fellow hams allowing us to link aboard their satellite system and WiFi router.

MP Antenna also produces some base-station antennas, offering wide-band coverage from 25 MHz to 6 GHz, great for scanners or clandestine radio applications on nearly any frequency.

“When tested in non-line-of-sight obstructed environments, the 6-element

M-Pole certified MultiPolarized antenna can outperform a single whip by at least 8 dBi,” comments Brian Gaul, sales manager for MP Antennas.

I even squeaked out some decent VHF/UHF contacts on the drive home in the rain from Quartzsite that weekend. Therefore, while it is not designed as an omni-directional *horizontal* antenna, it still does an okay job for weak-signal SSB and CW signals.

Fred at Universal Radio says he has many satisfied ham customers, who, not



Photo 5. MP Antenna's Sector 60, 2.4-GHz antenna.



Photo 6. Jetstream JTPS 30M switching power supply.

fully understanding the technology, agree it seems to make a difference. I like it because it looks strange on the comm van, and does just as well as a conventional VHF/UHF multiband whip, but without quite the height.

Contact MP Antenna for suggested pricing and spend some time with your laptop figuring out how you are going to take the antenna coax TNC and tie it in with your 2.4-GHz WiFi card. If you have a router, one with removable antennas, this will certainly give the router a big boost in range.

"Yes, our Trident 2.4 Antenna easily connects to many wireless WiFi routers such as D-Link, Linksys, Netgear, etc. It also connects to many USB WiFi cards as well, such as Hawking Technology, Alpha, etc.

"Our soon-to-be acquired resellers in the 2.4-GHz/WiFi commercial arena will be happy to help customers with inter-connect coaxial cables between our antennas such as the MP Antenna Sector 2.4-60/120 and Access Points, Mesh Radios, and CPE (Customer Premise Equipment) including POE (Power over Ethernet) types," comments Dr. Nilsson.

DC Switching Power Supply

At the fun R&L Electronics open house I had a chance to peek at the inside of the new Jetstream JTPS 30M switching power supply (see photo 6 and <<http://www.jetstream-usa.com>>, sales at <sales@jetstream-usa.com>). Quite nice! The switcher supply is small, lightweight, and efficient with no found radio birdies. An

analog meter with a cool blue LED backlight can measure voltage or current, and voltage is variable from 9 volts to 15 volts by a front-panel control. An accessory socket on the front offers cigarette-plug 12 volts DC output at 10 amps. A front-panel, 12-volt DC output is also available at 3 amps. The big power DC output is on the back of the equipment, rated at 30 amps. A cooling fan keeps the unit happy during prolonged transmission.

The four-page instruction sheet indicates: "Don't put any fraise in front of the cooling fan within 30 cm." I'm not sure I have any fraise hanging around my shack, but I'll keep the cats clear of the spinning fan.

I tried to short it out, and it instantly cycled down, and then reset after the short was removed. No spark; very smart. I ran it on some FM long-winded nets, and it barely got warm.

I like the nice rounded corners, and especially like the included DC current and DC voltage dual-function meter, which toggles between both on the front panel.

Just remember, if you want variable DC voltage via the front-panel knob, make sure the switch on the rear is set to "adjust." It took me a few minutes to figure out that one.

However, it took me only seconds to like this great, quiet power supply from Jetstream available at local ham radio dealers and R&L Electronics. See you at the next R&L bash!

With summertime approaching, tropo time is growing near, and the next issue of *CQ VHF* takes a look inside the tropo duct.

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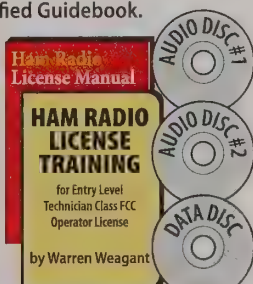
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Our 33rd Year

Twenty Years of ARRL VHF Contesting: With Emphasis on Portable Operations

Nearly 400 years ago Thomas Taylor once exclaimed, "Experience is the best teacher." A hundred years before Taylor, someone else declared, "Time will tell." Here WB2AMU tells of the lessons he has learned over 20 years of portable VHF contesting.

By Ken Neubeck, * WB2AMU

By the summer of 1990 I had accrued over 20 years of hamming on the HF bands. I was looking for something different to try in the hobby. Six meters and weak-signal VHF always seemed to be out there for me to explore, and I got my start in this realm when I bought a Swan 250 6-meter transceiver at a flea market in Long Island, NY.

By August I had rigged up a crude-looking 6-meter beam using an old TV antenna and actually made a contact with a local ham. I used a somewhat portable setup with this TV antenna and my Swan 250 sitting on a picnic table with AC power from the house in my backyard for the September 1990 ARRL VHF Contest. I had fun, as there was a good amount of line-of-sight activity during this contest. However, I had to shut down the station when the next-door neighbor complained of TVI, a situation that I found to be inherent with the band and particularly with the RF-leaky Swan 250.

Over the next six months, I did participate in the January 1991 ARRL VHF Contest from my basement station setup with a few line-of-sight contacts being made, but still nothing to show me anything special about 6 meters. It was not until the morning before the start of June 1991 ARRL VHF Contest that I finally experienced sporadic-E on the 6-meter band that carried forward into the contest. Then that I saw what was so special about the 6-meter band and this led to a



Photo 1. The author, Ken, WB2AMU, using a Swan 250 hooked up to a modified TV antenna on a mast mounted in the picnic table for his first-ever VHF contest effort that took place in September 1990 in the back yard of his house in Patchogue, New York. (Photo by Fran Neubeck)

renewal of my interest in ham radio.

For the next few years I made some station improvements, finding a TS-670 that was lower power and less TVI-prone than the Swan 250, along with setting up a permanent vertical antenna for the band. The additional benefit of the TS-670 was that it is a 12-volt radio and this led to some earlier experimentation with portable operation from my car. Again, this led to more refinements, such as a mag-mounted vertical quarter-wave 6-meter antenna

and the construction of a portable 2-element 6-meter Yagi, as well as the purchase of the FT-690 portable radio, which could run at 2 watts in battery mode or 10 watts with the amplifier attachment.

I was also finding out that my modest station at home was simply not going to be competitive for any of the three ARRL VHF contests with the better equipped and designed VHF stations that are located on Long Island. This is true when you examine my street name, Valley Road,

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which is actually down a hill but still at about 30 feet ASL or so. Therefore, I started exploring the option of improving my portable setup in my car at that time, a 1993 Plymouth Sundance, and finding optimal hilltop locations on Long Island from where I could operate. This resulted in an interesting trial-and-error period, when I operated from both the south and north shores of Long Island, typically running a 2-element beam and about 60 watts of power using a Mirage 1015A 6-meter amplifier with my FT-690 in the 2-watt output mode.

Eventually, I picked up the FT-290, which is the 2-meter version of the FT-690, and this led to a better contest effort so that I could go between two bands when conditions changed. The move to 2 meters brought up the need that hilltop locations were going to be required for best results for me. Thus, by 1995 I also realized that by operating at one of the highest points on Long Island during the three annual ARRL VHF contests I could efficiently operate a QRP setup with good results, although with some challenges.

Portable Operations

By 1995 portable and rover operations became the focus of my efforts from that point forward. At first I only had 6 meters and a simple two-element beam, but over the years I added additional bands and used different antennas to improve my overall score.

My initial effort in portable operations during the VHF contest was strictly on 6 meters. However, after a few years it became obvious that I needed to add some 2-meter capabilities for when the 6-meter band was quiet. I added an FT-290 to my arsenal in June 1995. This helped me become more competitive, and it led me to adding 432 MHz in June 1999 with an FT-100 radio and some limited 220-MHz capabilities with an ICOM FM HT in January 2003. Also, over the years I eventually migrated to three-element Yagi antennas for the 6- and 2-meter bands. It is important to realize that it sometimes may not be possible to get all of the equipment that you need at once, and gradual additions and improvements are a good way to go.

In June 1996 I made a long-desired trip to Wyoming and Colorado, where I did a rover operation during the June VHF contest. I had kept strictly to one band, 6 meters, as I did not expect a lot of activity on the other bands in the area I was



Photo 2. WB2AMU's QRP portable setup of a two-element 6-meter Yagi for the ARRL September 1996 VHF contest using his 1992 Plymouth Sundance. (This and remaining photos by WB2AMU)



Photo 3. A January 2003 VHF contest QRP effort with a 1998 Chevy Cavalier using a three-element 6-meter Yagi.

in. I was able to rig up the rental car to put out 150 watts to a mag-mount vertical, and I was very grateful when sporadic-E appeared at the beginning of the contest on Saturday and during Sunday morning. I think that going to rare grids during the June contest can be one of the most fun activities in which a VHF ham can participate.

There are challenges regarding portable operations. With portable operations, the ideal location for operating traditionally has been a hilltop or mountaintop location to get improved line-of-sight conditions for the VHF and UHF bands. Since I live on Long Island, where there are no mountains (don't believe what you saw in the opening scenes of the movie *Pearl Harbor*), the choice is confined to hills. Long Island has a limited number of hills, some in central Long Island, where the glaciers stopped years ago, and some on the north shore. Most of them are in the 200-foot ASL range, which may not seem like much, but it does help a lot in the moderately busy VHF activity found in the Northeast U.S.

I thought that merely securing a high point on Long Island would be easy and present no issue when I operated from a public park. However, I would soon find out that operating in a public area presents additional challenges compared to the safety of one's ham shack.

In January 1995, it was cold but no snow on the hill I chose. I was located at the far end and making contacts in the afternoon, after the contest had started at 2 PM. The parking lot was about 60 percent filled with cars, mostly with men just sitting in the front seat. At about three PM, two police cars entered the parking lot, followed by undercover police who were already there. I was in the midst of a full-fledged police raid. The police saw my portable antenna setup and left me alone while clearing the park of cars, enforcing a no-loitering rule. They came to me at the end, when I was the only car left, and told me that they understood my amateur radio activity but suggested that I secure permission from the county parks department in order to avoid any problems in the future. Indeed, I found that I would need paperwork from the county, after being asked to leave during another January contest in 1997 because of the no-loitering rule for the park.

If I had never gone to the hill in the first place, I would never have known about the weird situation that was going on up there involving the exchange of drugs,

etc. But because of the excellent height of the hill and it also being one of the few spots on Long Island where there is good line-of-sight in all directions, I became aware of the other situation going on. Likewise, parking lots in other locations in the U.S. could have activity that the average person may not be aware of. Thus, use caution when selecting an operating site.

However, I was determined not to be deterred. The way that I saw it was that ham radio was a legitimate and "good" activity that should be allowed in a public park. I thought that by shining a light on the darkness with the participation of ham radio in a public place, it would be a step in the right direction to correct the situation.

The situation did get better after several police actions during the early part of the new century when several dozen arrests were made. However, now I was the odd ball with regard to appearing "different." It was not be unusual for a police car to pull up next to me on a Sunday morning to check me out in response to a call of suspicious activity. I knew the

drill by now. I would stop operating, get my documentation, and get out of the car to talk to the police when they arrived. It seems ironic in the current climate that ham radio is not very well known by the public and can be "suspicious activity." I think that hams as a whole have their work cut out for them in the future to define ourselves to the public.

Therefore, I learned in short order that it is necessary to keep in mind that even if you are operating VHF from a public park, you may need to secure some kind of documentation ahead of time. Most municipalities will not have an objection if you carefully frame your request to say that you will only operate during daylight hours, or something of that nature.

Another thing is to keep your setup efficient and simple. For a number of years, I had a separate antenna for 432 MHz, but after making a contact on 432 MHz using the three-element 2-meter Yagi for that band instead, I realized that while I obviously lost some gain for that band, I gained in simplicity in the antennas setups, along with quicker band switching. During the great tropo open-



Photo 4. The January 2005 VHF contest effort with a 2004 Chevy Malibu using a three-element 2-meter Yagi.

ing that took place in September 2007, I made over 24 QSOs in 14 grids on 432 MHz using the 2-meter beam as a result of quicker switching between 432 MHz and 2 meters. (Recall that the FT-100 only has one output for 2 meters and 432 MHz, so much time can be lost if switching between two antennas.)

Propagation During the Year

For those stations in the quieter areas of the U.S. and Canada, the September and January contests present challenges in making contacts. Many stations deal with this challenge by going the rover or portable operation route. Some of the things to remember associated with each contest are outlined as follows:

ARRL January VHF Sweepstakes: During January, North America experiences a minor winter sporadic-*E* season. This is nothing like the summer season, as typically three or four days of sporadic-*E* activity may be seen during the month, leading to about a 15-percent chance that some sporadic-*E* may be observed during the 33-hour event of this VHF contest event. In 2008, I observed a three-hour opening from Long Island into Florida. In 2010, I observed no sporadic-*E* during the contest at all, yet a week later there was a string of days of long-duration sporadic-*E* openings. The point here is that sporadic-*E* lives up to its name, and while you hope for it to happen, it has to be viewed as something special.

During the peak years of a solar cycle, the January contest is pretty much the only event of the three where *F2* can be worked on 6 meters. In 2002 I worked into the West Coast and heard one of the biggest pile-ups in history when a ham from Iceland came on 6 meters on Sunday morning. Unfortunately, for that particular event the major opening to Europe happened on Saturday morning, prior to the contest. I am guessing that January 2013 or 2014 may have the possibility of *F2* activity on 6 meters for the ARRL January VHF Sweepstakes.

This situation leaves one to grind out primarily line-of-sight QSOs during the January event for the bulk of the contest period. Unfortunately, for many of our VHF operators in the U.S. who are not near major centers of VHF activity, this may mean only a few contacts if one stays at home. That is why rover and portable operations seem to be a viable option for many in this situation.



Photo 5. WB2AMU's rover effort in Wyoming and Colorado during the June 1996 VHF contest. This photo shows the rental car used by WB2AMU with a mag-mount vertical during a visit to grid DN61 in the mountains of Wyoming.

One can see that this is true by reading the soapbox submittals that are made for this contest on the ARRL website. There seem to be a fair number of rover team. I cannot think of a better way to break up the monotony of winter doldrums and cabin fever!

Thus, scores will not be high because of the propagation situation and most importantly because of the potential of bad weather. In my area of Long Island, there is generally the chance of snow, cold temperatures, and high winds. However, I know that it can be worse for stations north of me. Even home stations can feel the impact with ice on antennas, frozen rotators, and loss of power. The January event truly seems like a survival event for many VHF operators in the U.S. and Canada.

ARRL June VHF QSO Party: Sporadic-*E* is the wild card for the June event. There always seems to be some around, and the question becomes how long, how much, and in what areas. It really does not matter where you are located in the U.S. and Canada. You can

be in the middle of Wyoming and a massive sporadic-*E* formation could link you to the Midwest and you can make hundreds of contacts. When a major sporadic-*E* event occurs with multiple formations during the June VHF event, as it did in 2006, watch out! There is bedlam and signals all the way up to 50.300 MHz!

When a strong sporadic-*E* event occurs on 6 meters during the June event, it can impact the amount of activity on the other VHF bands. Thus, it is still important to be ready to go during the slow periods to work line-of-sight stations on 2 meters and up. The multipliers that are made on those bands are just as important as those worked via sporadic-*E* on 6 meters.

By the way, some unusual events have occurred in the past. During the June 2005 event, there was no sporadic-*E* at all, but a significant aurora event occurred in the northern states, accounting for some major activity on 2 and 6 meters. My portable setup was sufficient to work several VE3 stations on 6 meters using 10 watts, but it was not quite enough for me to work stations via 2 meters aurora.



Photo 6. Also during the author's rover effort in Wyoming and Colorado for the June 1996 VHF contest, this is the inside of the car with the FT-690 on the dashboard and the Mirage 1015A amplifier on the hood of the car.

The warm weather also makes this event ideal for portable and rover operations that can be coupled with vacations.

ARRL September VHF Contest: The September contest is traditionally the best time for tropo-related propagation to occur. Sporadic-*E* is very rare in September, and during high geomagnetic activity, aurora propagation is possible, but these would be considered treats.

Line-of-sight and any possible tropo enhancement are the keys for this event, with the focus on 144, 220, and 432 MHz.

The weather is generally still warm enough for favorable for portable and rover operations, with participation in these two categories fairly high for this contest event as well. Over the years I have noticed that changing weather patterns are common during September and

these have led to major tropo enhancements during the contest. An example is the September contest in 2008, when hurricane activity was pushing into the Carolinas and forcing weather patterns that were favorable for tropo ducts along the northeast coast of the US. Both 144 and 432 MHz were filled with activity during the Sunday morning of that event, and I was able to work over 24 stations in 14 grids on 432 MHz, an number that was double my normal.

When favorable tropo conditions occur, from Long Island I can work stations in Virginia and the Carolinas, even while using QRP power levels. I believe that there are other tropo paths in the rest of country that can occur during the September VHF contest, and sometimes a good heads-up can be gained by checking the Hepburn tropo maps on the internet as well as keeping an eye on the weather maps for front activities prior to the contest.

Thoughts for the Future

It is important to realize that a VHF contest is different than an HF contest, because in reality, there are regional winners and this changes among the three ARRL contests during the year. It would be difficult to say that a ham with the highest score in the U.S. during a VHF contest could truly be judged in the same manner as a high score U.S. winner in an



Photo 7. The surreal sight of the snow-covered landscape in early June 1996 with the temperature at 60°F!

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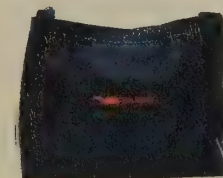
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HF contest. The inconsistency and nuances of propagation that occur during a VHF contest make this particularly true, compared to more uniform *F2* propagation patterns experienced on the HF bands. Also, some regions have decided advantages over others with regard to a fair amount of local activity on VHF to begin with. The Northeast is one such area, along with parts of California and in some Midwest areas that have a residual contact base of VHFers who can be worked within a 150-mile radius with moderate VHF equipment. VHF stations from more remote areas such as Wyoming, Montana, Idaho, and Utah only have a possible chance of placing well in the overall U.S. during the June contest when sporadic-*E* propagation may appear on 6 meters, whereas the September and January contests will likely not experience any significant sporadic-*E* propagation, leaving tropo and line-of-sight contacts as the only possibility for these stations. If the number of local VHF stations is low for these quieter areas, then the contest really becomes a very short-time affair and would keep the interest in VHF low.

I do not know how many more years that I personally will be able to do portable operations during the VHF contests. The setup is not particularly heavy, nor physically challenging, but some of the harsh weather conditions that are generally encountered during the January contest can really test your stamina. However, I still think that there is nothing better in the world during the doldrums of winter than to do some portable operating during a VHF contest, even if just for an hour or two.

I have noticed that there have been some issues with the number of stations participating in the contests as the years go by. I believe that both 6 and 2 meters seem to be the main bands, and I also believe that the June and September events will continue to hold their own. There are two or three areas that I believe could use some tweaking in the contest to better fit the band conditions, weather conditions, and band activity.

One major area that I think could help activity is to increase the value of 220-MHz QSOs from 2 to 3 points per QSO. 220 MHz is currently in the crosshairs of Congress for review and has been targeted as an area of interest for industrial use. A big problem is the lack of readily available SSB/CW radios for this band. However, there are plenty of 220-MHz FM



Photo 8. This is the current antenna setup that has been used by the author for his QRP portable setup since January 2007. The three-element 6-meter Yagi is on an umbrella stand, while the three-element 2-meter Yagi is mounted on a tripod situated on the roof of the car with the latter antenna also used on 432 MHz, mainly for simplicity. There is a mag-mount vertical located underneath the tripod which is used for 220-MHz FM.

radios. Perhaps by increasing the multiplier for a 220-MHz QSO, more stations will pick an FM transceiver and walk stations from other bands to 220 MHz during the contest. One could make a stronger argument for the multiplier to be raised by the ARRL to 4 points per contact, even if it was just for a one-year period just to kick up activity and help the overall band situation in the bigger picture. Ultimately, as hams we may regret the loss of the 220-MHz band in the future if we could have done something about it by promoting more activity. It would be a tremendous shame if hams lost this band, because some characteristics of 220–225 MHz are unique, and radio amateurs have observed the only recorded instances of sporadic-*E* propagation at this frequency.

I also believe that the January contest is a few hours too long for the number of stations that participate. Part of this is the competition from the NFL football playoffs that occur during the contest weekend in January. Another factor is that January in the U.S. and Canada generally means bad weather, and this takes a major toll on both rover and portable stations. Keep in mind that many of the public parks that these stations go to to oper-

ate have closing hours related to sunrise and sunset. Also, it can be hazardous for rover stations and portable stations to be operating during the night-time hours when bad weather (snow, ice, and wind) is present. Therefore, I would recommend the ARRL look at shortening this contest a little bit to meet the actual activity levels.

Another problem is the inherent dichotomy of the contests. While they are called VHF contests, it includes participation up to the microwaves. One would think that it would be called a VHF-Plus or a 50-MHz and Above contest. The problem is that the setups get more and more esoteric as you leave the UHF range, where dish antennas are required. Also, as you get into this range you need to identify your buddies who are within reasonable range and could be worked. While the three contests are a good avenue to promote this activity, I wonder if it would make sense to divide the participation level into three main categories: (1) the lower four bands (50 MHz to 432 MHz), (2) bands above 432 MHz, and then (3) all bands. All similarities among the types of propagation found on 6 meters and say 1.2 GHz are non-existent and the methods to make contacts are

By Ken Neubeck, WB2AMU

I also observed smaller, but significant openings on February 3, when I worked into a narrow grid field in Florida—EL96, EL97, and EL98 from 5:30 to 6:30 EST—and on February 7 at 10 AM. EST into EL87 grid inn Florida. Three 6-meter sporadic-E openings

I believe that the rover rules are generally fair, and the recent tweaking by the ARRL to make three categories for rovers (basic, limited, and unlimited) has helped promote more activity in this important category. It is apparent that rover operations are very popular with VHF hams, and it can sometimes promote a family-style activity, based on comments reported in the ARRL contest soapbox section. Indeed, this activity seems to be a popular thing during the January contest when getting out of the house is a good thing!

Figure 1. This plots shows a handful of contacts made at 0140 UTC, February 6, 2010 in the southern part of the U.S. and Mexico. (Plot by Jon Jones, NØJK)

Figure 1 shows a plot that Jon made of 6-

Therefore, in total, an estimate for North America 6-meter sporadic-E days in February 2010 is (represented in terms of North American time zones): 1, 2, 3, 4, 5, 6, 7, 9, 10, 11, 13, 19, 21, and 25, showing that at least half of the days in February saw some sort of 6-meter sporadic-E activity. As of this writing, who knows if this translated into some possible sort of activity during March of this year, typically the toughest month for sporadic-E activity in the Northern Hemisphere.

I might add that the rover and portable categories are a major part of making the VHF contests fun. Other than Field Day, HF contests do not have this category. The ability to operate an effective station using portable setups is something that may be very important to the survival of ham radio.

Beginning Experiments on the VHF Amateur Bands Part 2

In this, the second of a four-part series, KK7B writes about basic receiver fundamentals and guides the reader through building a simple 6-meter receiver.

By Rick Campbell,* KK7B

In my last article in the Winter 2010 issue of *CQ VHF*, I introduced a 10-mW VXO signal source for the 6-meter band. Generating a clean, stable signal has been the first step in radio experiments for a century, and a CW source is one of the basic blocks on a well-equipped experimenter's bench. In this article we will explore the next step: receiving and amplifying a weak VHF signal.

A radio receiver performs three basic functions: It selects the desired weak signal, amplifies it, and converts it into a form that will drive a speaker or headphones. These three functions are so basic that they have had many names over the history of radio, and as many different definitions. In this article we will introduce three receiver building blocks that perform those functions in an SSB or CW receiver and connect them together in a block diagram with a VHF antenna on one end and headphones or speaker on the other.

A circuit that selects some signals and rejects others is called a *filter*. A circuit that amplifies signals is called an *amplifier*. A circuit that converts a CW radio frequency (RF) electrical signal to an audio frequency (AF) electrical signal is called a *frequency mixer*, or just *mixer*. In Part 1, we built a stable signal source—an *oscillator*. With just these four blocks, we can build everything from low-power CW rigs for backpacking in the hills, to arrays of giant radio telescopes receiving signals from the edge of space. To recap,

here are the four basic RF building blocks:

1. Filter
2. Amplifier
3. Mixer
4. Oscillator

Amplifier

A receiver usually has more than one of each of those building blocks, so the list is in no particular order. Let's start with the amplifier block, because that block is easy to understand. An amplifier takes every signal on the input and multiplies it by a constant, called the *gain*. We can express the gain as a voltage gain or gain in decibels (dB), but the concept is the same. If the voltage gain is 1000, then every 1-microvolt signal on the amplifier input becomes a 1-mV signal at the amplifier output. Every 1-mV signal at the input becomes a 1-volt signal at the output, etc. A 6-meter CW receiver can easily hear a 0.1-microvolt signal, and in a quiet room you can hear a 10-mV signal on a small speaker, so a VHF receiver needs a voltage gain of more than 100,000, or 100 dB.

It is difficult to build a stable amplifier with 100 dB gain, but there are some 100-year-old receiver techniques that make it easy. However, as soon as we start amplifying, we realize that many signals arrive at the antenna, and if we have enough gain to amplify a weak VHF CW signal, the 1-mV signal from the local broadcast station will overload our amplifier. Thus, if our receiver includes amplifiers, it also needs filters.

Filters

A receiver has several different filters. All but the simplest, low-performance receivers have selectivity between the antenna and first amplifier. The first amplifier provides a little bit of gain—just enough to establish the sensitivity or “noise floor” of the receiver. After that first amplifier is a second filter. In old receivers the combination of two filters with an amplifier in between was called an *RF stage* and the number of RF stages was a figure of merit. However, modern receivers use just enough RF gain to do the job, and then convert the signal to an intermediate frequency (IF). The fre-

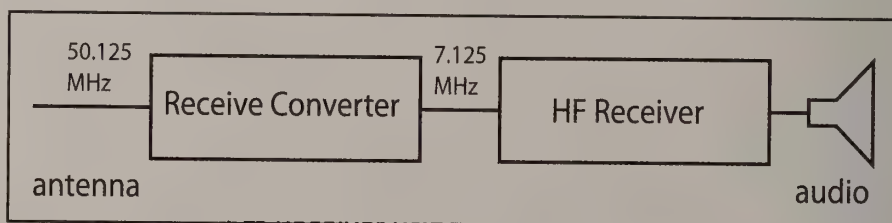


Figure 1. Block diagram of a VHF receiver.

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quency conversion is performed using a mixer, which is the next block.

Mixer

A frequency mixer is a block with two inputs and an output. When combined with filters, an amplifier, and local oscillator, it functions as a frequency converter. The RF signal is connected to one input, and the IF signal comes out of the output.

Oscillator

The other input to the mixer is a local oscillator (LO)—a few milliwatts on a frequency offset from the RF input frequency by the intermediate frequency. For example, if our RF signal is at 50.1 MHz and we want an IF signal at 7.1 MHz, we could use an LO at 43.0 MHz. If we want a tunable receiver, we can either tune the LO frequency from 42.9 to 43.4 MHz so that any signal from 50 to 50.5 MHz comes out at 7.1 MHz, or we can tune the IF from 7.0 to 7.5 MHz. Each approach to tuning a VHF receiver has advantages, and either approach can result in outstanding performance.

In addition to providing several convenient ways to tune a receiver, the frequency converter allows us to put some of the amplifiers at the RF input frequency, and some more gain at the IF. After we do the final frequency conversion to an audio frequency, we can add some more gain. A modern receiver might have 10 dB of RF gain, 20 dB of IF gain, and 70 dB of audio gain—enough to easily hear our 0.1-microvolt CW signal, and with most of the gain at audio, where both gain and selectivity are easily controlled—often using digital signal processing. The distribution of gain and selectivity is one of the most interesting challenges in receiver design.

Details of the Project

Figure 1 is the block diagram of a complete receiver for 6-meter SSB and CW signals. Figure 2 is a more detailed block diagram of the RF-to-IF frequency converter, and photo 1 shows the frequency converter fastened to the top of the diecast box containing the rest of the receiver circuitry. Now that we understand each of the blocks, it is easy to see the function of each piece of the 6-meter frequency converter. Six-meter converters were popular accessories in the last half of the

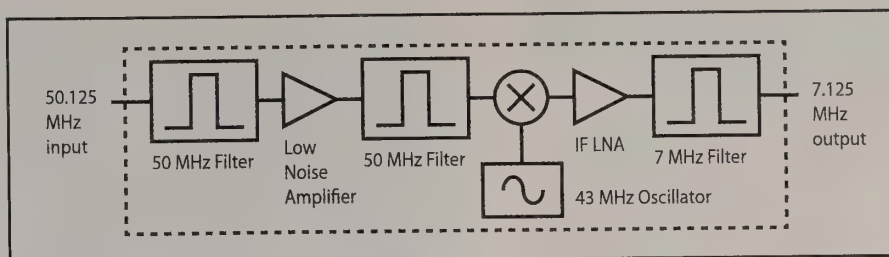


Figure 2. Detailed block diagram of the Rxc1 VHF receive converter.

20th century for high-performance weak-signal stations, and even today a good converter in front of a high-performance HF receiver might be used for a critical application such as moonbounce.

In the detailed block diagram in figure 2, the antenna is connected to a pair of tuned circuits that form a bandpass filter about 1 MHz wide. The output of that filter is a low-noise amplifier, and that drives a second filter. The output of the second filter is connected to the RF input of a passive-FET mixer. Passive FET mixers are a recent development with significant performance and cost advantages. They are a natural evolution of weak-signal techniques used in physics and radio astronomy in the mid-20th century. Western Electric and (much later) TriQuint Semiconductor designed and built three-terminal field-effect devices optimized for variable on-off control of

RF signals, but conventional FETs work just as well. The output of the mixer drives an IF amplifier with a broad tuned output. The LO uses a 43.000-MHz overtone crystal. The input filters and LO output stage tuning are designed so that the converter may simply be tuned up for maximum gain with a weak signal at the input. The CW source available from Kanga and described in the Winter 2010 issue of *CQ VHF* magazine is an ideal weak-signal source, and may be connected directly to the input of the converter without risk of damaging anything for initial tuning. The detector described in the Winter 2010 issue of *CQ VHF* magazine may be connected to the IF output.

Photo 2 is a close-up of the completed 6-meter converter built from the parts kit available from Kanga. The two filters with trimmer capacitors and amplifier transistor are on the top half of the board.

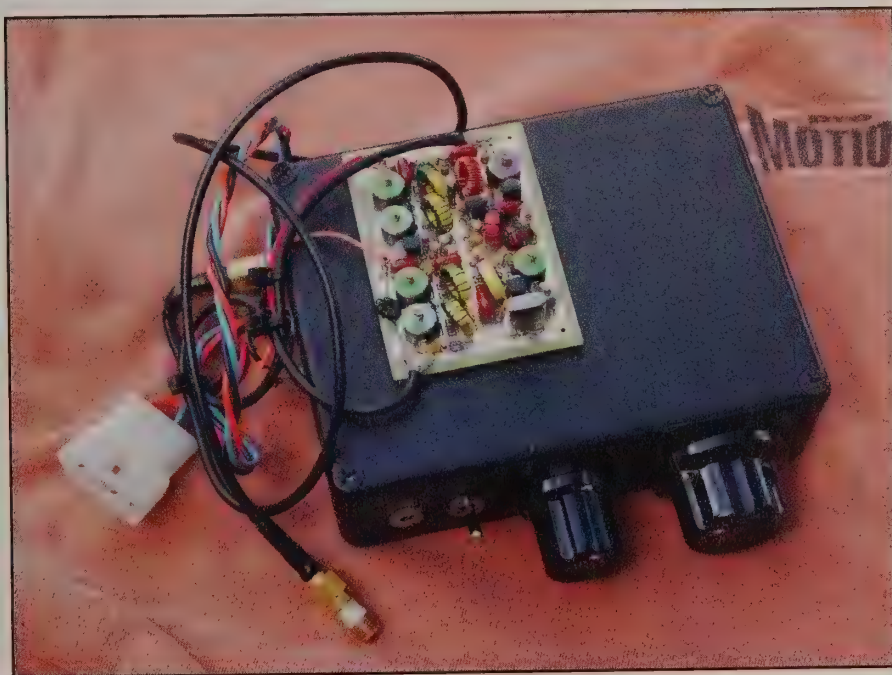


Photo 1. A Kanga Rxc1 6-meter converter transforms a simple 40-meter receiver into a good 6-meter receiver.

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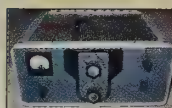
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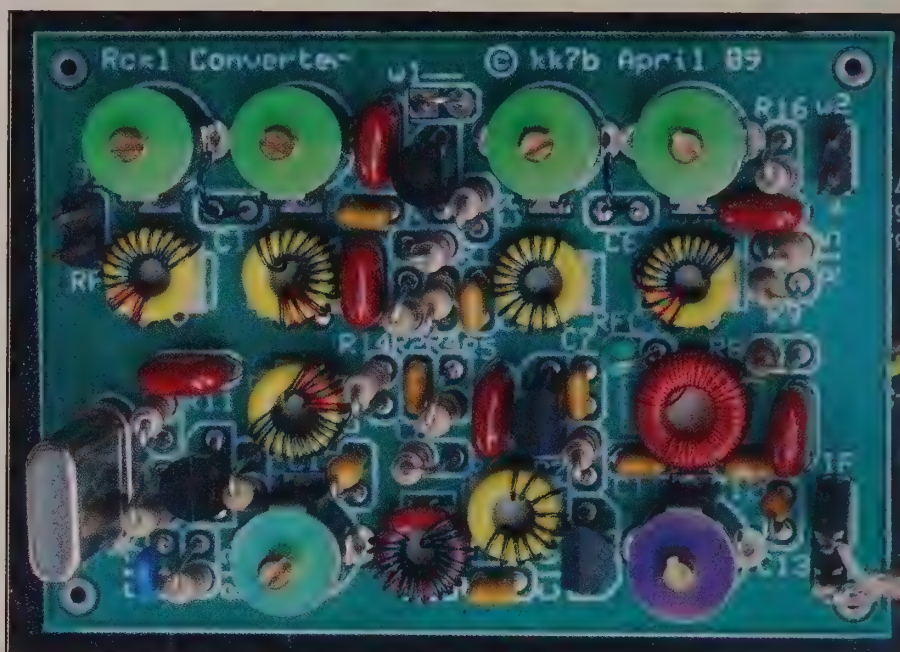


Photo 2. Here's a close-up view of the Rx1 receive converter. It is small but offers high performance.

The overtone oscillator with its crystal and trimmer are on the lower left, and the mixer and IF amplifier are on the lower right. The layout is compact, but does not require a microscope for construction. More details and the schematic are on the Kanga website pages (see: <http://www.kangaus.com/>). I start by winding the toroids and then mount them on the board.

The converter in the photographs uses small toroids, but there is room for larger ones on the circuit board. The trimmer capacitors have enough range to adjust for construction differences.

The converter may be used with any "tunable IF" receiver in the 40-meter band. This 6-meter converter converts a good 7.0- to 7.5-MHz receiver into a very

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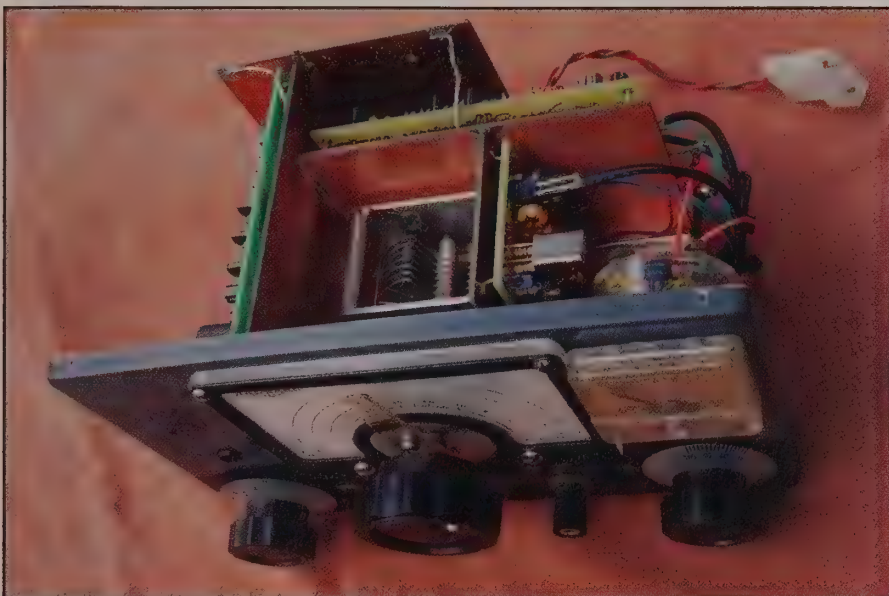
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Photo 3. For extra shielding, put the Rx1 in a diecast box. This is a very capable 6-meter weak-signal receiver using the new Rx1 and a vintage Drake 2A.



Photos 4 & 4A. The receiver techniques discussed here may be incorporated into transceivers. The receiver in this compact 6-meter SSB transmitter-receiver is electrically identical to the one shown in photo 1.

good 50.0- to 50.5-MHz receiver. The additional selectivity at both 50 MHz and 7 MHz contribute to basic IF receiver performance, and the gain and noise figure improve sensitivity. Even simple receivers for 7 MHz become better 6-meter receivers when used with this converter. Laboratory-grade HF receivers become laboratory-grade 50-MHz receivers. This old lore—adding a good VHF converter to a good HF receiver to make a very good VHF receiver—was part of the lure of VHF in the mid-20th century, and one reason that experimenters on a limited

budget were able to make significant contributions to radio science.

Performance

At KK7B, a half dozen of these converters have been used with everything from the laboratory receiver in the equipment rack to a 40-meter crystal set. The crystal set experiments were fun, but require good headphones to hear weak signals, and there isn't much 6-meter AM in my area. For a more practical receiver, connect the 50-ohm output from the con-

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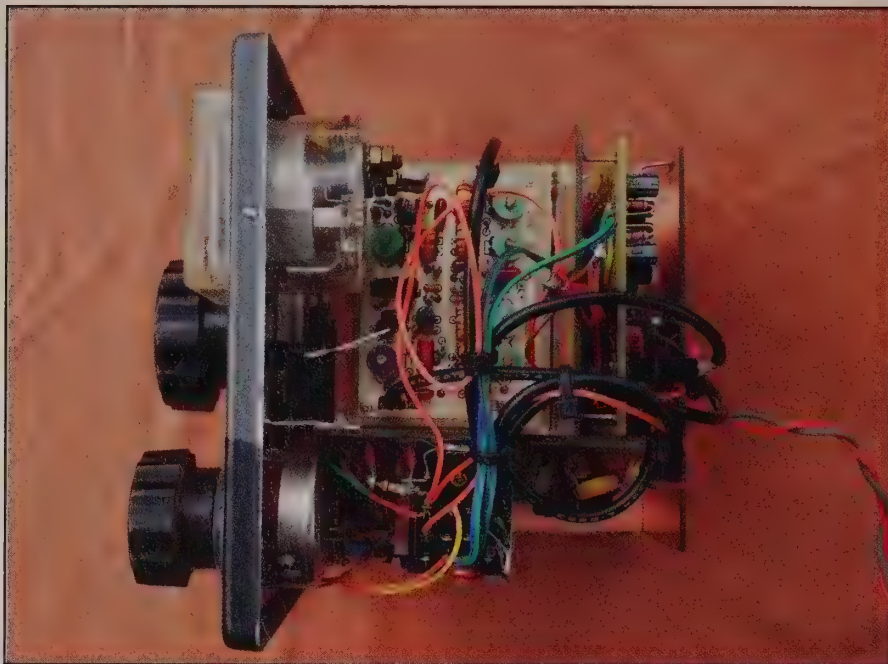


Photo 5. A look inside the 6-meter SSB transceiver. The internal chassis is made from soldered up PC board pieces.

verter to the antenna input of any 40-meter receiver you can get your hands on. A favorite approach at KK7B is to use a vintage SSB-CW receiver from the 1960s with a slide-rule dial and slow tuning rate. Basic receiver performance on the 7-MHz band was quite good in that era, and the combination of a good receive converter and good basic tunable IF receiver will outperform both 1960s vintage VHF gear and compact multi-band multi-

mode transceivers in 2010 that tune the VHF bands as an afterthought—without a single menu to navigate! Photo 3 shows a high-performance 6-meter receive setup at KK7B. The receive converter is in the die cast box on top of the old Drake 2A receiver.

For portable use, a smaller tunable IF receiver with long battery life is more appropriate. The receiver shown in photo 1 is assembled from modules available

from Kanga—the Rcx1 6-meter converter and microR2 40-meter receiver. Packaging of portable gear can be quite creative. Photos 4 and 5 show a microR2 tunable IF receiver and Rcx1 converter mounted in an old Heathkit Q-multiplier box, along with a simple 6-meter SSB transmitter. The 100-mW SSB transmitter uses an early prototype of the VXO 6-meter source described in the Winter 2010 issue of *CQ VHF* magazine and a microT2 exciter and amplifier described in December 2006 *QST*.

Here's a little hint: Note that the 6-meter converter is outside the diecast box in photo 1, and in a separate shielded compartment in photo 5. Good receivers have lots of shielding between the stages. It's easy if you plan ahead, but disheartening when you pack everything into a tiny enclosure and then hear lots of extra noise and whistles as you tune across a dead VHF band.

For experiments with ultra-portable operation on 6 meters, SSB may not be the best voice mode. Other options are AM, DSB without carrier, and FM. On line-of-sight paths, a few hundred milliwatts is plenty of power. FM is not my first choice for experiments. SSB is hard to tune while sailing a small boat or warming up (myself and the rig) by a camp fire. DSB is even more difficult to tune with simple receiving gear. AM is easy to generate, easy to receive, requires a little bit of experimentation, and is more fun to play with than any other mode. It looks cool on an oscilloscope, and it is easy to tell if a small adjustment to the station or antenna aiming makes an improvement. That's why AM is used in fox-hunting competitions.

A Portable 6-meter AM Receiver

Heavy iron AM transmitters with more than 20 watts carrier output are fascinating technology with a place on the HF bands, but for the VHF experimenter, low power AM—less than a few watts of carrier—offers significant appeal. In my next article we'll explore SSB, DSB, and AM modulators for the 6-meter CW signal source, but for our last project in this column, let's build a portable 6-meter AM receiver that the late Ed Tilton, WIHDQ, long-time ARRL member of Technical Staff and *QST* "The World Above 50 MHz" column editor, would have been proud of.

Tilton published a number of projects

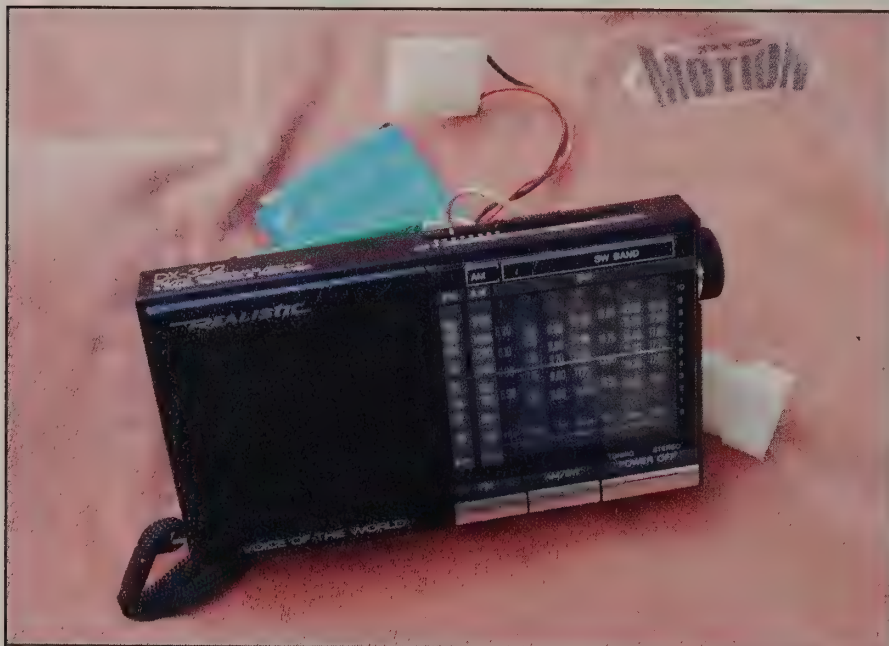


Photo 6. A simple 6-meter AM receiver made from a shortwave pocket radio.



Photo 7. Rear view of the 6-meter AM receiver showing the receive converter and the simple network to transform the whip antenna on the shortwave receiver to 50 ohms input.

in handbooks and journals that used a simple transistor converter in front of an AM transistor radio. He would have been delighted at the plethora of inexpensive shortwave portable radios on the market today. An excellent source is Universal Radio in Reynoldsburg, Ohio (see: <http://www.universal-radio.com/>). Just click on the "Portable Shortwave" link on the web page to see the current selection of several dozen models. The inexpensive ones have either a slide-rule dial with analog tuning, or a simple digital dial—also with analog tuning. Your local RadioShack may also have examples. Try several models until you find one with good performance on the 40-meter band, and don't pay too much, because you are going to crack it open and do a simple hack.

The only modification that needs to be done to the pocket shortwave receiver is to remove the telescoping antenna and add a short length of small coax with a connector. Solder the center connector to the wire that used to connect to the telescoping whip, and solder the coax braid to the nearest ground point. You can follow the ground traces back to the battery case—often the negative lead. Photo 6 shows a shortwave pocket radio that I hacked for an external antenna input.

The little whip antenna on a shortwave pocket radio is of very high impedance, so you need an impedance-transforming

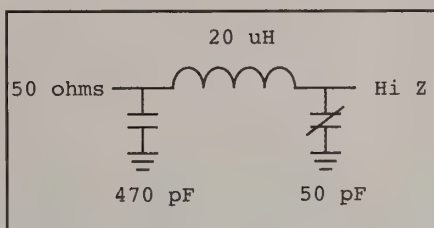


Figure 3. Schematic of a simple impedance-matching network to transform the whip antenna input of a shortwave pocket radio to 50 ohms.

network between that connection and the 50-ohm IF output of the 6-meter converter. The good news is that the network is selective, and greatly improves the basic radio performance of the portable shortwave receiver. The little pi-network I used is in figure 3. Photo 7 shows how I fastened the converter and pi-network to the back of my portable radio to make a 6-meter AM receiver. Batteries for the radio are inside, and the 9-volt battery taped to the back powers just the converter. This receiver is more sensitive and selective than the 6-meter AM receiver in my ICOM Q7a, and it is certainly easier to tune. It is quite handy for locating 6-meter noise sources.

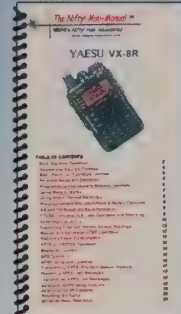
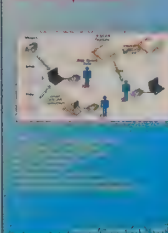
Until next time, enjoy the experiments, and start pulling the covers off your VHF gear to look inside.

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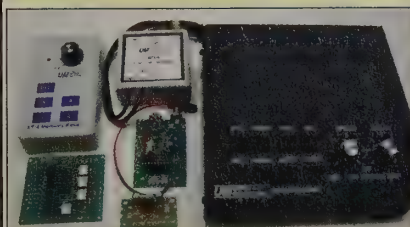
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Transoceanic VHF Ducting

A Simple Multifunction Beacon

A major problem with transoceanic ducting is having a signal to hear. Realizing this need, N7BHC designed a self-contained, transportable, rack-mountable beacon for almost all situations.

By Dave Pedersen,* N7BHC

In the Summer 2009 issue of *CQ VHF* magazine, we examined transoceanic ducting on VHF. One of the main reasons stated in that article why band openings often go unnoticed is a lack of activity. Beacons are useful propagation indicators in the absence of active stations.

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This article is based on N7BHC's presentation and Proceedings paper from the 2009 Southeast VHF Society Conference.

They transmit a signal at a stable frequency, power, and beam pattern. This allows distant receiving stations to have a signal to monitor for possible band openings.

Beacons are particularly useful in locations that do not have a lot of regular activity on the band of interest. This is especially true with transoceanic ducts where one end of the path has few or no active stations (photo 1). In many instances, DX operators have limited resources to invest in equipment. HF operation promises many more QSOs than VHF, so HF stations and operations are much more com-

mon. Most have little or no interest in or equipment available for VHF. A beacon project could build and deploy beacons at key locations for the purpose of studying extreme-range transoceanic ducting propagation. These beacons would be optimized for studying long-range transoceanic ducting.

Beacon Design Considerations

There are many possible designs for beacons depending on their specific purpose.



Photo 1. Some transoceanic duct paths. Those in blue have already been worked.

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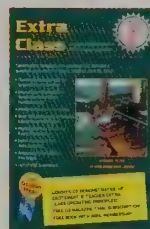
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VHF

The intended objective needs to be well defined before various design choices can be made. In this case, we're looking for a beacon to explore very-long-range transoceanic paths from remote areas. This implies high ERP (effective radiated power) over a specific path in order to optimize the chances for successful communications. The beacon is to do double-duty and function as a station to work DX as well. These design criteria will define the beacon design and implementation. As these beacons will mostly be deployed in remote locations where there is little or no existing VHF DX activity, they need to address issues such as poor electrical power, overseas shipping, and very limited local spare-parts availability.

Mode. Modern digital modes such as JT-65B and WSPR provide several dB advantage for weak-signal detection over long paths. However, not as many listening stations are equipped to listen for and work the digital modes. In addition, these beacons will be in remote areas often without the accurate time reference source that JT-65 and WSPR require. It's also unlikely that there will be a computer on site. However, the addition of a small PC using a GPS receiver for time

reference is practical in areas with reliable power. Phil, FR5DN, started with a simple CW beacon bus and has upgraded to a dedicated PC running WSJT to his 2-meter and 70-cm beacons. Phil has successfully worked ZS2 several times as a result of his beacons.

PSK-31 would be another good digital mode, and it does not require an accurate time reference. PSK-31 still needs a computer on site, although in the past small PSK-31 keyers were available. If a PSK-31 keyer were available, it would be well worth considering for remote beacons.

Simple on-off keyed CW is easy to decode, simple to implement, uses readily available keyers, and is widely recognized. Modulated CW sent as FSK is also possible, but adds complexity and increases duty cycle.

Transceive capability. The beacons for researching new transoceanic paths play a very important role in detecting band openings. In order to exploit the detected conditions and actually work DX, a transceiver is required. By using a multimode transceiver as the basis of the beacon, both functions are supported in a single package.

Power output. The radio, amplifier,

and power supply should all be run well below their maximum ratings. This reduces heat and increases longevity and reliability. As high ERP is desired, a 160-watt amplifier turned down to 80-100 watts is ideal.

Antenna selections. The antenna system needs to be chosen with the intended propagation path in mind. The antenna to be used for long-range beacons needs to have as much gain as possible while still addressing the desired target region.

Coastal stations would probably use a unidirectional antenna system beamed toward the target area. If all the target stations are within a narrow beam angle, a high-gain single Yagi with 15-25 elements might be suitable. However, if the target stations are spread over a large angle—e.g. a beacon in the U.S. aimed at Europe and North Africa—a much wider horizontal beamwidth is required. A small Yagi of 5-6 elements will give a 50-60° E-plane beamwidth, but its low gain would not increase the overall ERP very much. The solution is to use a large vertical array of the small antennas, with 4-16 Yagis stacked vertically.

Mid-ocean stations on islands have a bit of a dilemma. They typically need to

beam at coastal stations in several directions. They need either omni- or bi-directional antennas. These might be several stacked loops, or a wire-based H-Quad-bay. The basic H-Double-bay antenna can be seen at W4GRW's web page at <<http://wvfisher.googlepages.com/hdoublebay>>. The concept can be expanded to use four, six, or even eight or more slots. An advantage of this design is low cost and complexity.

Off-the-shelf components. All items used in the system should be readily available and not require custom electronics. This improves the reparability and lessens the design and construction complexity and cost.

Cost. Several beacons will be required to cover the paths of interest. It is important to keep the cost as low as possible. Overseas shipping needs to be figured into the cost as well. In some cases, import duty will have to be paid, too, which in some countries can be over 50% of the equipment value. Many of these beacons will need to be subsidized or paid for entirely by donations. An arbitrary maximum value of \$1000 per site, including shipping, has been applied.

Simple multifunction beacon. The simple multifunction beacon concept presented in this article is based on a VHF multimode radio with an amplifier and keyer. A UHF beacon can be built using the UHF equivalent radio, amplifier, and antenna. The system operates as a beacon most of the time. When a band opening is reported, the local operator can turn off the beacon and use the same equipment to work DX.

Local host. A local operator interested in trying VHF is absolutely vital to host the beacon. The local host will find a site for the beacon, install and maintain the equipment, and work the DX when the band opens. He will also be responsible for licensing of the beacon. Finding a local ham who is interested and catches the vision to try extreme-long-range tropo experiments is probably the biggest challenge of all. It may require years of patience and effort on his part.

The Simple Multifunction Beacon in Depth

Let's now take an in-depth look at the design criteria and decisions for the simple multifunction beacon. We will also review the construction techniques for the first several beacons that have already been built.

Concept. The simple multifunction beacon concept used by N7BHC is based on a small multimode radio with an amplifier and keyer. The system operates as a beacon most of the time. When a band opening is reported, the local operator can turn off the beacon and use the same equipment to work DX. This allows two-way contacts to be made with the same equipment. The design in this article profiles a VHF beacon operating on the 144-MHz (2-meter) amateur band, but the principles are directly applicable to a 430-MHz (70-cm) beacon as well, or even to other bands.

Design. The design selected is fairly simple. There are undoubtedly more efficient modes and equipment to use. However, simplicity and reliability are considered extremely important. Another consideration is size and weight, as the shipping costs to remote locations can be very expensive.

An all-mode 2-meter radio is the basis for the beacon. A simple memory keyer generates CW at about 12 wpm. The radio can also be used as an SSB or CW transceiver when the band is open. The radio drives a 160-watt amplifier. The output power on the radio is reduced in beacon mode to run the amplifier at the 80–100-watt output level, keeping the amplifier cool and increasing reliability and MTBF (mean time between failure). The radio is switched to full power in operate mode to boost the final output to the full 160 watts. A switching power supply rounds out the equipment line-up. The whole assembly is assembled on a 3U standard 19-inch wide rack shelf about 18 inches deep.

Equipment Selection. Many products were considered and tested in coming up with a simple and reliable beacon/transceiver station. There are countless variations of beacon design; the design here is built around the design criteria and goals already outlined. Different objectives and criteria will lead to other equipment choices and designs, but all will share the same basic tenets of putting a signal on the air on a chosen frequency, power, mode, and direction so DX stations can listen for it. All beacon designs will include several common elements such as radio/amplifier, antenna system, power supply, keying, host operator, and so on.

Radio. The radio forms the basis of the simple multifunction beacon. It needs to be capable of operating on CW as a beacon, and on CW, SSB, FM, or digital modes when used for two-way commu-

nications. This means an all-mode radio is required. Models are available for both mobile and base-station installation. The mobile radios are used in this beacon design to cut down on weight and size. Base-station radios would be adequate or even better performers, and can be used if size, weight, and cost are not factors to be considered.

Another consideration is that the radio needs to be a VHF-only model. If an all-band radio covering HF is provided on a beacon shipped to a remote location, it may eventually be removed from the beacon and put to use on HF, which would mean the beacon would be taken off the air.

The radio and amplifier selection need to be considered together. The radio at its maximum power should drive the amplifier to full output in two-way operation. The radio should also have a low-power mode that can be adjusted to drive the amplifier to the desired output level in beacon mode.

Several models of radio were considered for the beacon design, and several were tested before selecting the Kenwood TR-751A for the 2-meter band. The TR-851A is the 70-cm equivalent. The radios that were considered are:

- Kenwood TR-9000 and TR-9130. These radios were tested and functioned well as beacon transmitters. They are older models, and the receivers are not as good as more modern radios. They do require a good receive preamp when used in two-way mode. The biggest downfall of these units is that they lose their programmed frequency and mode memory when DC power is removed. The memories would need to be reprogrammed after every power failure at the site, requiring a local operator who can make repeated trips to the beacon site. If the beacon is not monitored often, it may even be off the air for weeks or months before the problem is found and rectified.

- Kenwood TR-751A. This radio is the next generation after the 9000 and 9130. It has a very good receiver and retains its memory if power is removed. The radio has adjustable low- and high-power settings. It also provides a relay to key the amplifier, eliminating relay chattering in the amplifier. The radio is readily available on the used market at very reasonable prices.

- Kenwood TM-255A. This may be the ideal radio for the beacon. It has excellent sensitivity and is the final generation of 2-meter all-mode, single-band mobile

radios produced. It is quite scarce on the used market and sells for 50–100% more than the TR-751A. It is slightly larger than a TR-751A, making integration onto the 19-inch rack shelf more difficult. The TM-455A is the UHF version.

- ICOM IC-260A and IC-290A/E/H. These radios are of the same generation as the Kenwood TR-9000 and TR-9130. They also lose programmed memory data if power is removed and were therefore not considered suitable.

- Yaesu FT-480R. This is another pretty-good performer of the same generation as the TR-9130 and IC-290A. It does not lose its memory if power is removed, but it only puts out 10 watts and is fairly large, making mounting in the rack-mount shelf configuration chosen difficult.

Keyer. The keyer generates the beacon sequence. The simple beacon transmits CW, so a simple memory keyer would suffice, with the radio operating in CW mode. An improved beacon would use both a digital mode such as JT65, WSPR, or PSK-31, and CW on alternate sequences. The digital mode would provide the weak-signal enhancement of the mode, while many more operators not equipped to decode the digital modes could receive CW. One additional complication of the JT-65 and WSPR modes is that the keyed sequence needs to be transmitted at precise time slots. That would increase the complexity and cost of the entire beacon, requiring a computer with an accurate time reference, possibly GPS based. The simple CW keyer is the chosen solution for these simple multifunction beacons.

- Several CW memory keyers such as the PicoKeyer were evaluated. While they did the job, setup required a CW key or paddle. They did work and are viable options.

- The Hamgadgets ID-O-Matic was selected, as it is designed with beacon operation as one of its modes. It is programmed via an RS-232 serial port and can be built in about an hour. Dale Botkin at Hamgadgets provides excellent technical support.

Amplifier. Several models were considered. Reliability and ruggedness are vital for beacons installed in remote locations. As the amplifiers considered were designed for intermittent service, external fan cooling is required. The FCC limit in the U.S. for unattended beacon stations is 100 watts output, so 160-watt amplifiers were selected. The radio's low-power output is adjusted to provide the correct drive required for the amplifier to

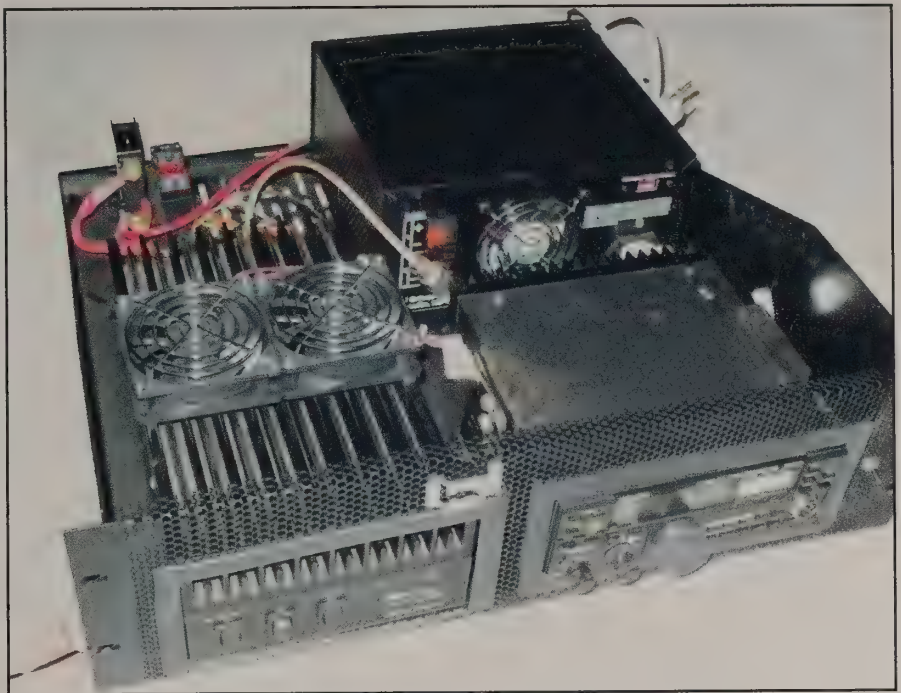


Photo 2. A completed "Simple Multifunction Beacon."

operate at the 80–100-watt output level. This also helps the amplifier run cooler, further increasing reliability. The fuses and fuse holders on the amplifiers have been problematic, and they are bypassed and an external circuit breaker used for amplifier fusing. Two amplifiers were ultimately selected as being suitable.

- RF Concepts 25/160-watt models. There are several models available. The most commonly used is the RFC 2/315. Some models do not have external hard PTT keying. This is required for reliable keying, especially at low CW speeds. A serious problem encountered with one unit was no heat-sink compound on the final transistors, leading to early failure.

- Mirage B2516G. Earlier models of this amplifier have been found to be more reliable and better built than the newer ones. The fusing on these amplifiers is internal on the circuit board.

Power Supply. The radio and amplifier require 35 amps at 13.8 volts DC when transmitting on high power. A PSU of 45–50 amps provides enough reserve capacity to operate reliably. While a linear supply is very capable of meeting the power requirement, a switching supply was chosen to reduce the weight for overseas shipment.

The MFJ-4245MV power supply was selected. It provides 40-amp continuous and 45-amp surge current capacity at 13.8

volts. It has proven very reliable over many years of use with not a single failure experienced. An external switch selects either 110 or 220 VAC input. Metering indicates the supplied voltage and current draw. Two fans cool this supply well even in moderately high-power beacon use. The exhaust air is quite cool. Careful positioning of the power supply directs the exhaust air across the radio heatsink, doing double-duty in cooling the power supply and radio.

Construction

The simple multifunction beacon (photo 2) can be built onto any suitable frame or even left on a desktop. The physical layout ultimately chosen was a 19-inch rack shelf, 5.25 inches high and 18 inches or more deep. This allows the entire beacon to be assembled in a compact package with all components anchored in place, increasing reliability and simplifying shipping and installation. Locations without a rack in which to mount the beacon can easily use a metal or wood cabinet to house the rack shelf.

Rack Shelf. The standard design frame is a 19-inch vented rack shelf. A 3U 5.25-inch high shelf makes a compact assembly (photo 3). A 4U 7-inch high shelf would offer additional top clearance for better cooling in hot environments. The shelf needs to be at least 18 inches deep to

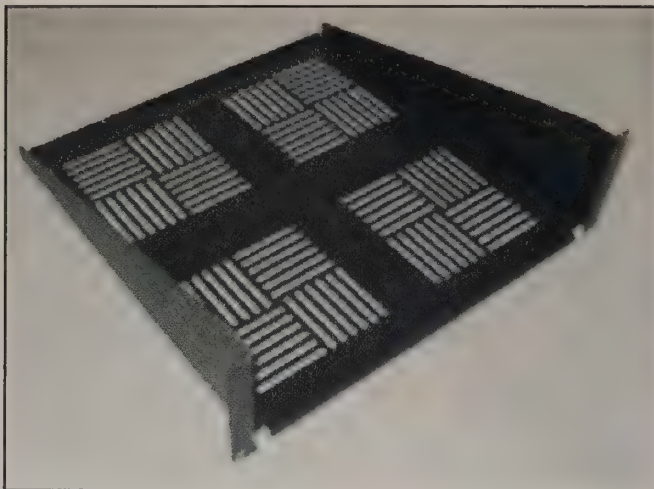


Photo 3. A 3U rack shelf holds the entire beacon.

accommodate the depth of the radio with the power supply behind it. The venting slots make installing the amplifier and other equipment very simple with self-tapping sheet-metal screws inserted from the bottom.

Rack front panel. A vented front panel protects the equipment while allowing reasonable air flow. Cutouts are made to go around the radio and amplifier. The cutouts are made larger than the radio and amplifier by $\frac{1}{8}$ to $\frac{1}{4}$ inch. The sharp metal edges of the cutouts are covered with a rubber or plastic edge guard. I have found the outer vinyl covering of $\frac{1}{4}$ -inch coaxial cable to be a very good low-cost solution. Slice a length of coax down its length with a sharp knife or razor blade. Cut to length with 45-degree beveled corners and slide over the sharp metal edge. The keyer on-off switch, CW key jack, and a microphone hanger are attached to the front of the rack panel.

Layout. Photo 4 shows the overall layout. The radio is on the front right, with the power supply on the rear right. The amplifier is on the front left, with DC power distribution at the rear left. The keyer location is not critical, but is usually nestled near the front between the radio and the right edge of the rack shelf to facilitate the keyer on/off switch and an external key jack if desired.

Radio. The TR-751A radio is mounted on the front right side of the rack shelf, and has a few small modifications to make it easy to adjust some internal controls when fixed inside the rack shelf.

It is positioned so the front-panel metal work is $\frac{1}{8}$ inch in front of the rack front-panel ears. Mounting the radio an inch or two from the edge of the rack shelf allows better air flow and cooling. If the radio's original clamshell mobile mount is not available, simple aluminum L-brackets can be used to support the radio. The height of the radio can be optimized when using the L-brackets so that the middle of the heatsink on the rear panel is the same height as the middle of the power-supply exhaust fan.

There are three internal trim pots on the TR-751A that typically need adjustment:

Drilling three small holes in the top cover of the radio makes these accessible without having to remove the radio from the rack shelf and remove its top cover. They trim pots to be adjusted are:

- CW sidetone level. Some locations are manned, and the

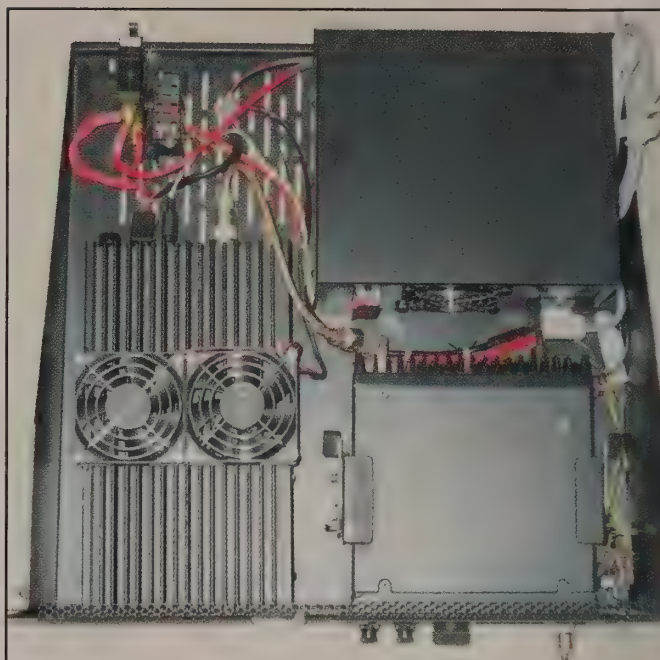


Photo 4. The beacon equipment layout.

continual sound of the CW sidetone is apparently not universally appreciated.

- Break-in delay. Adjust this control so that the radio does not chatter between receive and transmit between characters while transmitting. If the PTT function on the ID-O-Matic is used, this adjustment is not required.

- Low-power drive level. Adjust this control so that the drive produced in low power drives the amplifier to the desired output power. Most amplifiers tested need about 8–10 watts to produce 100 watts output.

The TR-751A provides a relay closure to key the PTT line of an external amplifier. The 4-pin connector is very hard to find. Most of the time one needs to be manufactured. Fortunately this is quite easy. Here is the process I use:

- Remove two pins from a DB9 male connector. Apply heat with a soldering iron until the plastic softens and pull the pins out with a pair of needle-nose pliers.

- Solder a length of hookup wire to each pin.
- Support the radio exactly vertical with the face down.
- Place a piece of masking tape across the rear-panel accessory socket.

- Spread a thin layer of Vaseline or silicone grease across the tape over the area of the connector.

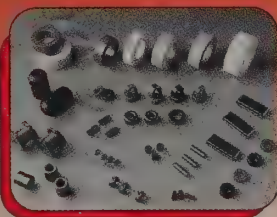
- Push the two pins with wire previously described through the masking tape and into their two pins. Be sure to use the correct two locations in the socket.

- Modify the plastic shell from a $\frac{1}{8}$ -inch phone plug by cutting off the narrow end, or find some other length of $\frac{1}{4}$ -inch plastic tube about $\frac{3}{4}$ inch long. Feed it down over the wires from the two pins.

- Mix up some 5-minute, two-part epoxy. Carefully drip it down into the connector shell while holding the shell firmly against the masking tape to prevent leakage out the bottom. I use a toothpick for this process.

- After 5 minutes the epoxy will have set well enough to stay in place without holding the connector shell. Let it rest another

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er 5–10 minutes and then remove it from the radio.

- Remove the masking tape. The connector is now finished.

Amplifier. The amplifier is mounted on the right front of the rack shelf (photo 5). It requires a small modification to operate reliably in long-term beacon use.

Mounting. The amplifier draws cooling air in through vents on its bottom and side. To enhance cooling, replace the rubber standoff feet with larger 1/2-inch high self-adhesive feet. The amplifier is secured to the rack shelf with self-tapping metal screws that come through the slots on the rack shelf and screw into the narrow slots on the bottom of the amplifier. If your amplifier does not have vent slots on the bottom, remove the amplifier cover and position it in place on the rack shelf. Observe where components are located in the amplifier, and then drill four holes through the shelf slots and up into the amplifier case. As an alternative, L-brackets that secure to the screws on the side of the case to the heatsink could be used.

Amplifier fuse. The fuse holders and fuses on the amplifiers are weak points. In high duty-cycle extended operation, the fuses tend to age quickly and fail after



Photo 5. The amplifier and cooling fans.

one to three months. On the RF Concepts amplifiers, the poor fuse-holder/fuse-connection exhibits moderately high resistance, leading to significant heating of the fuse holder and fuse. Temperatures more than 80° F above ambient on the back of the fuse holder have been mea-

sured after just 10 minutes of operation. The Mirage amplifiers have a much lower resistance fuse holder, but it is located inside the amplifier. If it does fail, the amplifier must be removed from the beacon to change the fuse.

The solution is to jumper the internal



Photo 6. The power supply is positioned so its cooling fan also cools the radio's heatsink.

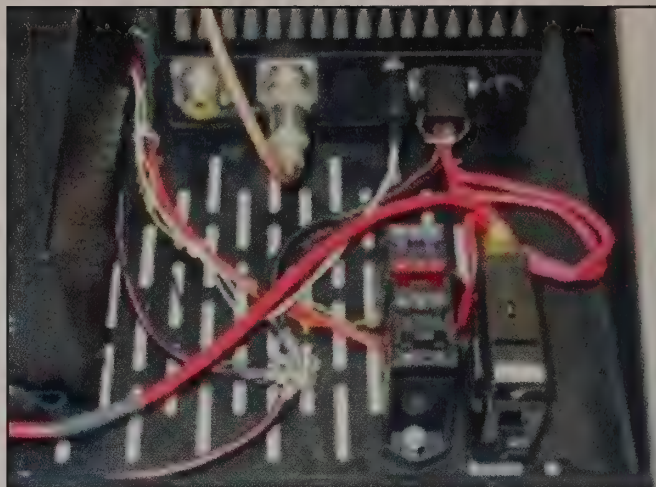


Photo 7. The DC wiring. Note the fuse holder and the amplifier's circuit breaker.

fuse holders and use an external fuse, or better yet, a circuit breaker. A 30-amp magnetically tripped external circuit breaker replaces the fuse. These are more reliable than the thermally tripped breakers in this application.

Cooling. The amplifiers are not designed for extended, high-duty-cycle operation. Although the CW transmission is about 30% duty cycle, and 15-second receive periods every minute allow additional cool-down time, the amplifiers still run hot, shortening the component life. Two 80-mm muffin fans provide additional cooling. The fans use ball roller bearings for long life and quiet operation. They are run at 13.8 volts off the primary supply. The amplifier heatsink runs at less than 5°F above ambient air temperature with two fans. The fans are glued to each other with a superglue, and then super-glued to the heatsink, blowing air down onto the heatsink. Fan guards protect from prying fingers and prevent any wires or tools from falling into the blades.

Keying. The amplifiers should be hard keyed for PTT rather than rely on RF keying. The Mirage amplifiers use a closure to ground. The RF Concepts amplifiers can either use a ground or +12-volt line for keying. Set the jumper in the RF Concepts amplifiers to use ground for keying (move the wire to the [–] pin internally). This PTT line is keyed by the relay output from the TR-751A.

Preamp. The preamp is normally left off to avoid wear on the preamp relay. It also affords an extra level of protection from nearby static discharges while

receiving. The preamp is turned on when the beacon is being used as a standard radio to work DX.

Keyer. The Hamgadgets ID-O-Matic keyer kit is very inexpensive and easy to build. Here are few extra pointers.

- Observe antistatic procedures while handling the FETs and the PIC processor.
- Use an external 10K-ohm trim pot in line with the speaker to reduce the sidetone level.
- If the keyer does not operate properly, checking for incorrect settings in the additional parameters shown by setting Repeater (Y) can prevent operation, even if the Repeater (N) setting is used.

One can use the settings for “Beacon” mode, but there is an even simpler setup suggested by Dale at HamGadgets. The settings I use on the ID-O-Matic keyers are as follows:

- ID Time: 15 (15 seconds Rx time between beacon transmissions)
- Yellow time: 0
- Blink time: 0
- ID Msg, *callsign/B grid callsign/B grid callsign/B grid*: 15: (call and grid 3x, 15-second carrier)
- Beacon Msg (blank)
- Alternate Msg (blank)
- Auto CW ID: Y
- CW Speed: 13
- ID Audio Tone: 702
- Repeater: N

The keyer is typically installed between the radio and the left side of the rack shelf. This is convenient for external wiring to the on-off switch that is in the DC supply line.

The only output used is the CW keying line (pin 5) and ground (pin 6).

The keyer does provide a PTT keying line. This can be used to place the radio in transmit, eliminating the need to adjust or have access to the radio's PTT delay control.

A front-panel jack can be wired in parallel with the output of the keyer to allow the use of an external key for CW operation.

Power Supply. The MFJ-4245MV power supply is mounted on the right rear of the rack shelf. It is mounted facing the rear of the assembly. This permits easy access for viewing and wiring. In addition, it directs the exhaust air onto the radio's heatsink (photo 6).

Mounting is accomplished with two self-tapping sheet-metal screws coming through the rack shelf slots onto existing holes on the bottom of the power supply. The power supply is positioned so that the front-panel attachment lugs do not extend beyond the rack shelf.

The AC power cord can push up against the radio heatsink. Either position the power supply and radio to avoid a conflict, or use a right-angle AC power plug. Set the power supply to the correct AC input voltage.

Wiring. There are three categories of wiring on the beacon; DC power, keying, and RF.

The *DC wiring* is the most complex part of the wiring (photo 7). All power is run from the large front-panel lugs on the power supply to a power distribution area behind the amplifier where all devices are individually fused.

The 8-AWG black negative lead goes to a large bolt mounted vertically from the bottom of the rack shelf. The negative leads from the radio, amplifier, and keyer are terminated to lugs attached to the same bolt.

The 8-AWG red positive lead goes directly to the lower (input) bolt on the 30-amp DC circuit breaker. The circuit breaker is just for the amplifier. An 8-AWG red wire from the circuit-breaker output bolt goes directly to the amplifier.

An 8-AWG red wire goes from the lower (input) bolt on the circuit breaker to the DC fuse panel. This fuse panel uses blade automotive fuses and holder, as they are most commonly available overseas. A 10-amp circuit breaker is used for the radio, 3-amp for the fans, and 1-amp for the keyer. Individual wires go to the radio and keyer, and a single wire feeds the two fans that are wired in parallel. Spare fuses should be stored with the beacon.

The *keying wiring* connects the keyer and front-panel key jack to the radio, and the radio to the amplifier.

The keyer outputs on pins 5 and 6 are CW keying and ground. These go to the key input on the radio, a 1/8-inch mono plug. A 1/8-inch mono jack can be mounted on the front panel if an external key will be used to operate CW. It should be wired in parallel with the keyer output lines.

The TR-751A provides a relay closure to key the amplifier. The amplifier side uses an RCA phono connector. If a different radio is used that does not have a relay output, it may have a PTT line that goes low on transmit which could key the amplifier. In addition, the keyer has a PTT output (pin 4) that can be used to key the amplifier directly.

The *RF wiring* is just a cable from the radio to the amplifier. My preference is to use an RG-142/U double-shielded Teflon cable.

The antenna can connect directly to the amplifier output or through a wattmeter.

Surge Protection. Many beacons are in remote installations. Following established grounding and surge-protection practices will result in fewer failures and costly repairs, less down time, and fewer trips to the beacon if it is remotely located. I consider it cheap insurance.

The two cables to provide surge protection on are the AC power line and the antenna lead.

Heavy duty AC surge protectors such as the ICE 330 or 331 (110 or 220 VAC) are ideal. Consumer-grade products tend to fail easily in harsh environments.

RF surge protection should be installed on the antenna lead at the building entrance. The ICE 302 and PolyPhaser IS-50NX are good products.

Summary

Beacons have proven invaluable in spotting and working many transoceanic ducts. The KH6HME multiband beacons on Hawaii are a shining example of beacon use for tropo ducts and are how most operators in California are alerted to W6-KH6 openings.

The simple multifunction beacons presented in this article have proven their worth already. FR5DN on Reunion Island operates a beacon at his home beaming towards South Africa (photo 8). In August 2007, ZS2GK started hearing the beacon, and within a few days the first FR5 to ZS QSOs on 2 meters SSB and FM took place. In 2009, Phil added WSJT and 70-cm capability. In August he and ZS2GK had the first digital QSO.



Photo 8. The first FR5DN multifunction beacon.

Phil's web page is <<http://www.astrorun.com/~fr5dn/radio/tropo/tropo.html>>.

The N7BHC beacon pictured in much of the article is in operation from Oriental, North Carolina, in FM15PA. It is beaming towards Gibraltar with a KLM 2-meter 16LBX Yagi at 50 feet. The actual power at the antenna feedpoint is 60 watts after feed-line losses take their toll. In August 2008, CT1HZE copied a few short bursts of the beacon in IM57 in southern Portugal, a range of 3,707 miles on 2 meters. The propagation appears to have been meteor-enhanced sporadic-E for at least part of the path, with tropo ducting possibly responsible for the eastern half of the circuit.

More beacons are required around the world's coastlines if we are to discover and work new tropo ducts across the oceans. The next beacon is already built and ready for deployment. The only thing that is holding back its installation is finding an interested operator willing to host and install it. Prime locations of interest are the Cape Verde Islands, Bermuda, and West Africa. Several more simple multifunction beacons are also planned for the Caribbean, and a "Super Beacon" is in the works, but that's a whole different story.

HOMING IN

Radio Direction Finding for Fun and Public Service

Innovators in RDF: An Inventor, a Code Writer, and a Fox Meister

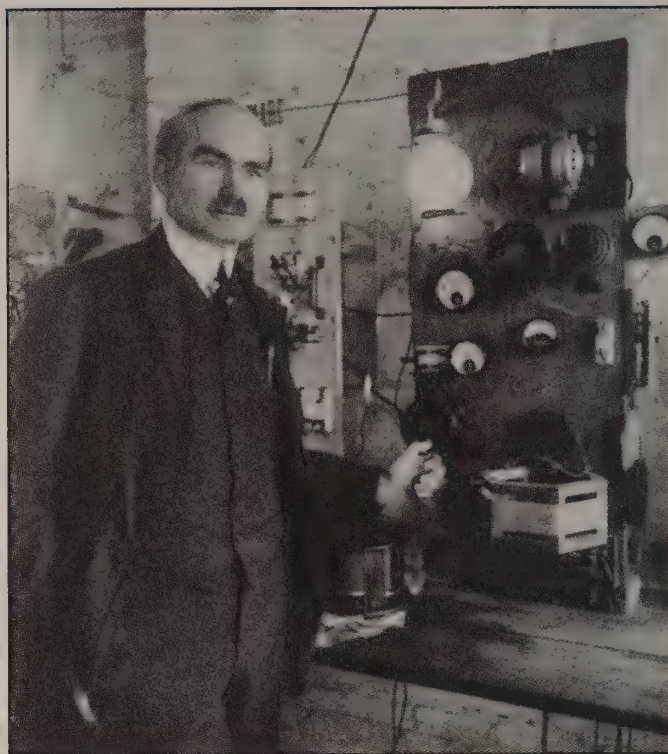
I know you share my oft-expressed wish that we might live until the 21st century, just to observe the state of radio and television then.” Those were the words of radio pioneer Lee de Forest on a Sunday afternoon nationwide radio program in March 1941. “Startling changes are in store,” he continued, “but I have a hunch that the little grid will be found in our radio and amplifier tubes even then.”

Lee de Forest has been maligned by some for not fully understanding the physics behind his Audion, the first triode tube.¹ However, there can be no doubt that his fragile glass bottle with wires helped make it possible for him to achieve a succession of “firsts” in electronic communication. Radio telegraphers at the Brooklyn Navy Yard near his laboratory were startled to hear the “William Tell Overture” on their receivers amid the dits and dahs they were copying from ships at sea, as de Forest became the first to play phonograph records over the air. He also made the first sports broadcast, his voice sending the results of Sandusky, Ohio yacht races 14 miles from a boat on Lake Erie to the shore.

Like many inventors, de Forest suffered rejection and ridicule. Even though his Audion receiver was more sensitive than the crystal detectors then in use on battleships, the US Navy refused to procure it because it required a battery which might spill acid on the sailors as the ship swayed. The US government sued him in 1912 for selling stock in his Audion company, saying in court that his claim of a device like an incandescent lamp that could both transmit and receive radio waves was impossible² and belittled the work of the great Edison.

De Forest’s appearance on that NBC show was about nine months before the USA entered World War II. He didn’t yet know the role that the gridded tube would play in radar displays and in television, nor about the microwave transmitting tubes that would be developed for the same purposes and would still be in wide use today. Solid-state amplifiers, switches, and flat screens predominate in most consumer products on the market now, but for the utmost in simplicity, there is still a place for the vacuum tube. I continue to use my home-built cathode-ray bearing display³ on some of the local mobile transmitter hunts.

One of de Forest’s many interests was radio direction finding (RDF). Before he invented the Audion, he submitted a patent application for improvements in wireless telegraphy that took advantage of the directional properties of multiple-wavelength antennas.⁴ He noted that straight end-fed horizontal wires of 200 feet to a quarter mile in length have bidirectional gain in the direction of the wire orientation. He also noted that long conductors such as telegraph wires and railroad tracks would guide these low-frequency radio waves.⁵



Lee de Forest is best known for inventing the first amplifying vacuum tube. He also experimented with directional antennas for wireless telegraphy.

De Forest’s patent, which was not issued until eight years after his filing, claimed that multi-element directional transmitting and receiving antennas as well as grounding to railroad tracks would “increase the efficiency of transmission of electromagnetic waves over land and increase the efficiency of duplex working.” Not bad for someone who didn’t have the benefits of sensitive field-strength meters, antenna ranges, and NEC software. It is unclear whether he actually built a switched antenna receiving set for the long wavelengths in use then, but his concept is very much like military microwave RDF systems of today, as well as the switched-antenna amplitude-based RDF method that I described in my last column.

Foxhunting— Now There’s an App for That

A century ago, innovators used components such as triodes, capacitors, and transformers to make new products. Today, the building blocks are often subsystems such as GPS engines, cam-

*P.O. Box 2508, Fullerton, CA 92837
e-mail: <k0ov@homingin.com>

era boards, and smart phones. Software tools are now as important as hardware tools. Computerized plotting and triangulation of RDF bearings has been around for a few years, but FoxHunt™, a new iPhone application, makes it possible to do it all on foot. Its creator is Bob Iannucci, W6EI, a MIT-trained engineer and computer scientist.

Among his many activities, Dr. Iannucci is founder of RAI Laboratory, which produces the RadioPort™ USB sound-card interface for hams. He got the idea for FoxHunt when he and his wife Susan, W6SJI, went with friends on their first mobile transmitter hunt with the San Francisco Bay T-hunt group. It was supposed to be an easy one that they could do with handie-talkies, hand-held Yagi antennas, and paper maps.

"Even though we got the magnetic declination right, we made the error of assuming that straight-up on the map was true north," Bob wrote. "It was actually about 30 degrees off true north. This caused us to 'spiral in' toward the fox because all of our bearing lines were off by 30 degrees. We never found it.

"I realized that my iPhone 3GS could do a better job of keeping track of all the bearings than I could," Bob continued. "It has a compass, GPS, Google Maps, and a good set of programming tools. Within two weeks, I had the app coded and tested."

The present version of Bob's program⁶ doesn't interface directly with radios or RDF antennas. It's just a very simple way for anyone to triangulate bearings from multiple locations and display the bearing intersections on Google Maps. After getting a bearing with his or her RDF system, the user looks in that direction while holding the iPhone directly in front. The phone's GPS engine and internal compass determine location and azimuth, and then the program puts a bearing ray on the display map. When multiple bearings are entered, the best triangulation is computed and displayed, as shown in the illustration.

W6EI explains that you can give the bearings different weights, based on your confidence of their accuracy. The app will take this into consideration in estimating the fox's position. From the list of previously taken bearings, you can select any one and its line will turn red. Then you can edit its perceived quality rating (number of stars) or tell the triangulation routine to ignore it.

Bob says that on his first hunt with his new app, its triangulation predicted the



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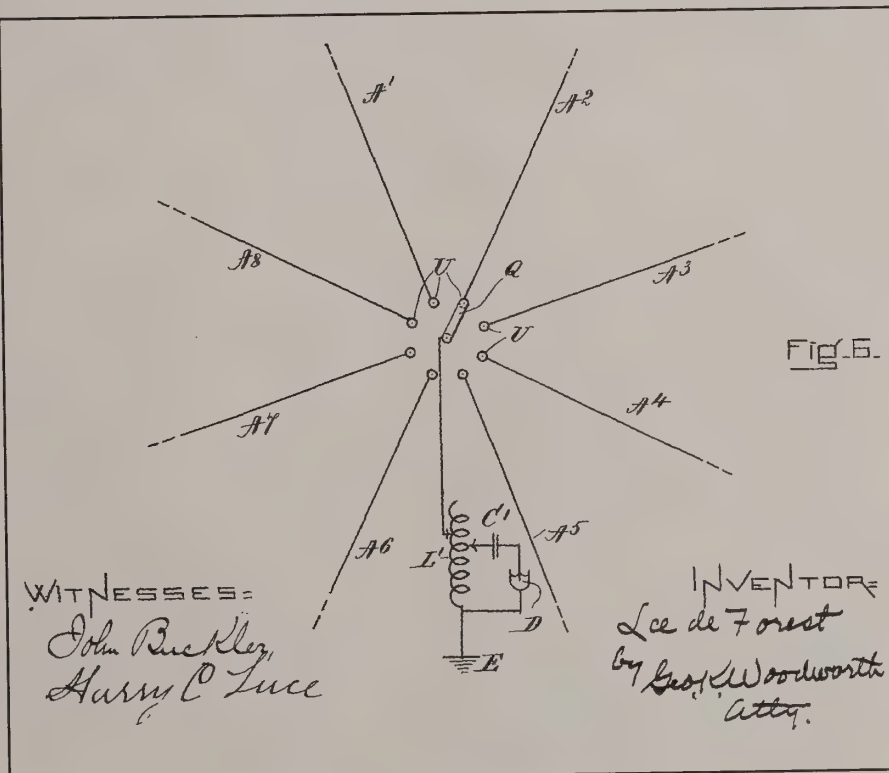
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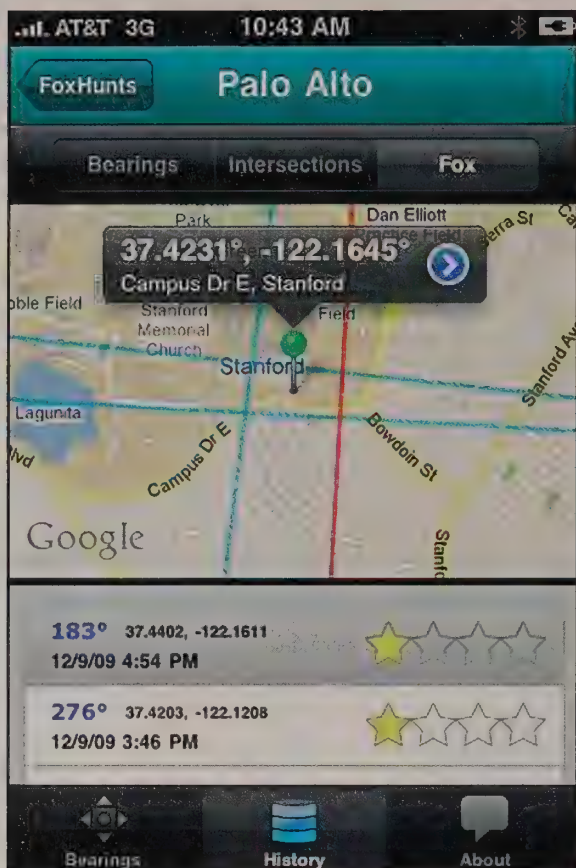
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Is this the first electrically rotated radio direction finding antenna? Lee de Forest received a US patent for it in June 1914.



Triangulated bearings on the screen of an iPhone with the FoxHunt™ application. There are four bearings; the selected one is red. The program makes a best estimate of the fox location (the green pushpin), based on the confidence level given to each bearing.

A Busy Month of May for RDF Contesters

Hidden transmitter hunters have a wealth of opportunities to have fun in May 2010, starting with the annual Foxhunting Forum at the Dayton Hamvention® on Friday, May 14. As of this writing, it is scheduled for Room 2 at the Hara Arena beginning at 11 AM. Hosting the forum will be members of the OH-KY-IN Amateur Radio Club and the Butler County VHF Association.

Then a week later, the USA ARDF Championships get under way a short drive south of Dayton, with practice and equipment testing. On May 22 and 23, there will be separate contests in separate forests on 2 meters and 80 meters with five fox transmitters to find on a course that will be about five kilometers from start to finish each day. Detailed schedules, lodging information and registration forms are available at www.usardf2010.com.

As always, the USA championships are open to anyone at any fox-hunting skill level, with or without a ham license. Just prior to the championships, on May 19–20, there will be two days of optional intensive training in radio-orienteeing, providing an ideal way to get a jump-start into the sport. More information about the rules and techniques of ARDF is at www.homingin.com.

The USA ARDF Championships take place on the 13th annual CQ Worldwide Foxhunting Weekend, sponsored by sister publication CQ magazine. But since the primary objective of this event is more fox-

hidden T location to within 100 feet from a distance of 10 miles. That's a bit too good to be true, considering that this would require each bearing to be accurate within a tenth of a degree. Even if there are no signal reflections, you can expect your results to vary from that, depending on the pattern of your RDF antenna and how well you can sight your bearings from the antenna boom while looking at the screen of the phone. However, the app corrects for magnetic declination, keeps you from making math and plotting errors, and is definitely "cool."

Since it was first offered on December 21, FoxHunt has been downloaded 489 times by iPhone 3GS owners in the USA and 686 outside our borders. Some of them are hams, while others are in law enforcement and professional search-and-rescue work. Bob welcomes suggestions for improvement as he plans his next version. "The current app is free but supported by advertising," he says. "The new Pro version will likely be ad-free but will bear a modest price tag."

W6EI continues, "I am considering a teaming feature for sharing bearing info between phones, an augmented-reality feature that will overlay bearing and intersection information on the view from the iPhone's camera, and the capability to manually enter bearings by the numbers. This may enable those with iPod Touch and older iPhones to use at least some of the features of FoxHunt."

Bob says it would be easy to develop an electrical bearing transfer interface between the iPhone and RDF sets, whether Dopplers or rotating antenna azimuth encoders. He has also dropped some hints about designing and producing a high-tech Doppler RDF unit of his own design to work with FoxHunt. If you are interested in being a beta tester for new products from RAI Laboratory, make contact via the RAI website.⁷

International rules forbid GPS positioning and mapping for participants in formal Amateur Radio Direction Finding (ARDF) contests. Competitive radio-orienteeers are expected to do it the old-fashioned way, with paper maps supplied by the course-setters and their own hand-held compasses. Expect the

hunt participation, there's no insistence that your event be on that weekend. Any time in the spring is fine with us!

Details and stories of Foxhunting Weekend are in the April and May 2010 issues of CQ. For many clubs, it kicks off a season of regular transmitter hunts. For others, it's a special once-a-year event, like Field Day. Some groups prefer formal hunts with carefully crafted boundaries, specifications for signal parameters, time limits, and so forth. Others are completely content by just having at least one signal to hunt. No need for any more regulations, they say.

Make your Foxhunting Weekend activities into a magnet for every club member. Better yet, include the whole community, especially young people. Invite a Scout troop to experience on-foot transmitter tracking or to ride along with the mobile hunters. Look for opportunities to incorporate foxhunting into Scout activities such as Camporees, Scout-O-Ramas and Jamboree-On-The-Air. Seek out other youth groups that might be interested.

Afterwards, write up the results and send them to me. The list of information in a complete CQ Foxhunting Weekend report is posted at www.homingin.com. Happy Hunting!

Joe Moell KØOV
ARRL ARDF Coordinator



Tim Kreth, AD4CJ, teaches direction-finding techniques to newcomers in the Nashville area. (Photo by Craig Lamb, N4BAX)

organizers of championship ARDF events to forbid the carrying of iPhones by competitors from now on.

Foxhunting in Music City

Hidden transmitter hunting has come to central Tennessee in a big way. Members of the Williamson County Amateur Radio Emergency Service (WCARES) are learning about the sport and developing their skills under the leadership of Tim Kreth, AD4CJ, a cardiologist in Brentwood. "I've been a ham for 15 years or so and have always been interested in this," he told me. "So I mentioned it to the guys and they said, 'OK, you're in charge.' They call me the Fox Meister."

Tim is justifiably proud of WCARES, saying, "We have a little over 160 members. We've been very busy with a six-week class for Technicians licenses with 30 students. I think 22 have passed already. We had ten students who took our class for General upgrade and I think five have passed their tests so far.

"We really encourage our young hams. There is a club net every Monday night that gets 50 to 75 check-ins. For a half-hour prior to that, there is a youth net that is organized by a couple of adults, but we let the youngsters be Net Controls. We have a really great club communications system with five linked ham repeaters covering middle Tennessee. When one of the youngsters announces his or her presence there, almost every time an adult will come up to chat within 20 seconds."

Because of the large number of youth, WCARES has only been doing on-foot foxhunts instead of hunts in cars. Starting with a couple of foxboxes to find, the club is now ready to do five-fox hunts under international rules. "We don't have a fixed date and time for our hunts," Tim explains. "It's whatever my schedule will allow.

"Six to twelve people show up for each of these hunts, so it's really a lot of fun. We've had a big building effort for 2-meter

tape-measure Yagis⁸ and I have three of them that I let people borrow if they haven't built theirs yet. Some use loop antennas⁹ instead. Both active¹⁰ and passive RF attenuators are popular. For about twenty minutes before each hunt starts, we'll explain foxhunting techniques to those who haven't done it before. More often than not, the experienced adults will go out with the first-timer youths to help them learn the ropes."

With plenty of experience in signal tracking, WCARES members were ready to jump in when interference kept local officials from using the Linked Emergency Telecommunication System (LETS Talk), a new public safety voice communications network that will eventually provide interoperability over the entire state of Tennessee. "The LETS Talk repeater for Williamson County is actually in Davidson County," says Tim. "It's on a hill in downtown Nashville, about 25 miles north of our county's Emergency Management Agency (EMA) offices. A dead carrier on 156.015 MHz was holding up that node, so it had to be disconnected from the rest of the network.

"The EMA people know us very well, so they called us and asked if we could help find the problem. Gary Heddon, W8JFP; Randy Armour, KI4LMR; and I started at the hill. Phil Sherrod, W4PHS, had written a computer program for triangulation, so he was at a local headquarters spot. Each of the rest of us had RDF gear and a hand-held GPS unit so we could transmit our bearings and exact locations to Phil.

"We took our readings at the affected repeater, where the signal was 10 dB over S9. Then we drew a circle on the map 5 miles out and we spread out at 120-degree angles from there. None of us could hear it there, so we moved in to just 2.5 miles away and we were all able to pick up the carrier again. W4PHS plotted it and the bearings intersected at a Highway Patrol office, only a third of a mile away from the hill with the affected repeater. When we got there, we used our Yagis and loops to pinpoint it.



Clara Hedden, granddaughter of Gary Hedden, W8JFP, learns about ARDF bearing-taking at a foxhunt of the Williamson County Amateur Radio Emergency Service. (Photo by Dave Mann, N4CVX)

We were able to tell exactly which of the six antennas on the pole was the one from which the carrier was coming.

"We knocked on the door of the Highway Patrol dispatch office that Sunday afternoon and told them that they had a stuck radio interfering with LETS Talk. One dispatcher immediately said to the other, 'I wonder if that's why we've been having trouble with our communications!' When they came in Monday morning, the Highway Patrol technicians found a backup VHF radio that was keyed down."

Tim says that the triangulation program by W4PHS predicted the actual stuck transmitter location to within a few dozen feet. That's possible, since it was quite close and its antenna was up on a high pole, giving reflection-free bearings to the hunters. Phil's program doesn't have the street-mapping features of W6EI's FoxHunt, but if the bearings and user locations are accurate and correctly entered, the triangulation will be right. "He used the same program for one of our hunts in the park," says Tim. "The triangulation was a quarter-mile off because one of the guys hid his fox next to a chain-link fence!"

Next Time

My next "Homing In" column will have coverage of the USA ARDF championships in Ohio and the organization of ARDF Team USA for the World Championships in Croatia this September. I'll also take a look at another new computer program for display and triangulation of RDF bearings. It works on fast PCs, has a serial Doppler interface for mobile transmitter hunting, and displays the results on Google Earth.

73, Joe, KØOV

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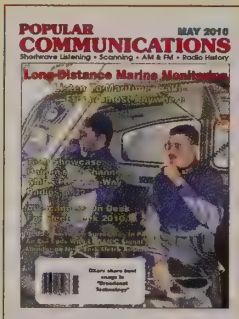
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Notes

1. Lee de Forest's patent application vaguely mentions a "gaseous medium" inside the tube and states that "... the explanation of this phenomenon is exceedingly complex and at best would be merely tentative; I do not deem it necessary herein to enter into a detailed statement of what I believe to be the probable explanation." Edwin Armstrong later showed by measurement that the triode's grid-to-filament voltage controls the flow of electrons from filament to plate and that a high vacuum is best.

2. "Even a man cannot talk and hear with the same organ," sneered the prosecuting attorney. De Forest was eventually acquitted, but the judge urged him to "get a garden variety of job and stick to it."

3. <http://www.homingin.com/nscope.html>

4. From US Patent 1,101,533: "... the objects of my invention are to provide transmitting and receiving systems whereby the radiation of electromagnetic signal waves may be concentrated in a definite signal direction and whereby the general direction from which the electromagnetic signal waves which operate a receiving device emanate may be determined ..."

5. From US Patent 1,101,533: "I have discovered that all longitudinal cross-country conductors, such as railway tracks and masses of telegraph or telephone wires act as wave-chutes and lead off the waves in the direction in which they extend, thus draining the ether of the wave energy in their immediate neighborhood. Thus if a transmitting system ... is operated in the immediate vicinity ... the maximum field of force will be created in the direction of said track or line wire system."

6. <http://foxhunt.rail.com>

7. <http://www.rail.com>

8. <http://www.homingin.com/equipment.html>

9. <http://www.arrowantennas.com/fhl.html>

10. <http://www.homingin.com/joek0ov/offatten.html>

SATELLITES

Artificially Propagating Signals Through Space

“Satellites 101”

An Introduction to Amateur Radio Satellites

I have been encouraged recently by the increasing number of new hams at hamfests, club meetings, and public service events. Many of them are expressing an interest in amateur radio satellites, and I feel that it is time to re-introduce the wonderful world of amateur radio satellites to this audience. Possibly this will catch a few “old timers” as well.

A Brief History

We have kept our “satellite secrets” well. Many new hams have no idea that amateur radio satellites even exist, much less that we have been building and launching them since Orbiting Satellite Carrying Amateur Radio number one (OSCAR-1) was launched on December 12, 1961. Beginning with OSCAR-1, the early satellites were built, coordinated, launches arranged for, etc., by a group in the San Francisco Bay Area known as Project OSCAR (*for some of the history of Project OSCAR, see the article “Amateur Radio and the Cosmos, Part 4” by WA2VVA elsewhere in this issue—ed.*). In 1969, most of that responsibility was taken over by the Radio Amateur Satellite Corp. (AMSAT), founded in the Washington, DC area. There are now related AMSAT organizations in many other countries throughout the world. AMSAT is over forty years old and is still building and launching satellites with only one paid employee.

As satellites are placed in orbit and become operational, they typically are assigned an OSCAR number such as AO-07 for AMSAT OSCAR 7 or HO-68 for HOPE OSCAR 68 (the newest satellite from China). Russia also has an amateur radio satellite series known as Radio Sputnik, or RS. So far there have been 68 OSCARs and at least 30 RS satellites, for a grand total of nearly one hundred amateur radio satellites launched. At any

given time, there are usually about a dozen satellites of all types active. A listing and status of all of the amateur radio satellites is available on the AMSAT web page: <http://www.amsat.org>.

Amateur radio satellites may be further classified by orbit type, operational mode, frequencies used, and ease of use.

Orbit Type: LEO, HEO, & GEO

LEO: Most amateur radio satellites are placed in a Low Earth Orbit (LEO). A LEO is usually a circular orbit and the orbital altitude is usually 350 to 1500 kilometers above the Earth. Most of these are polar orbits—i.e., passing over the Earth’s poles (orbital inclination of approximately 90 degrees). However, there are exceptions, such as the International Space Station (ISS) and Saudi OSCAR 50 (SO-50).

If the orbital altitude is around 750 kilometers and the inclination is approximately 98 degrees, the orbit becomes “sun synchronous,” meaning that it will make its passes over any point on the Earth at approximately the same time each day. For example, AO-51 will make two or three passes each in view of Fort Worth, Texas centered around 6:00 AM and again at around 6:00 PM each day. Each pass will last around 10 to 15 minutes and time between passes will be approximately 100 minutes. These same criteria will exist for any other point on the Earth as well. AO-27’s passes are centered around 2:00 AM and 2:00 PM. Departures from the ideal orbital altitude and inclination will cause a slow drift of these parameters relative to the time of day.

If the orbit is not “sun synchronous,” the orbit passes will drift around the clock in a regular and predictable fashion, but they will occur at different times each day.

The duration of each pass and the maximum communications distance will depend upon orbital altitude, with the ISS having the shortest passes at the current

time of about 9 to 10 minutes and the smallest communications circle diameter (footprint) at about 3000 miles; altitude is 350 kilometers. Our old friend AO-07 has pass times as long as 20 minutes and a footprint that will permit QSOs from the U.S. to Europe; altitude is 1500 kilometers. The new Chinese Satellite, HO-68, at 1200 kilometers altitude has the second greatest footprint at the moment.

HEO: All of the satellite “old timers” yearn for the return of the High Earth Orbit (HEO). HEO can cover a variety of high-altitude orbits. The one that has been used most often for amateur radio satellites is a modified Molynia Elliptical Orbit with an apogee (highest altitude point) of 36,000 to 60,000 kilometers and a perigee (lowest altitude point) of 1000 to 2000 kilometers. Orbital inclination ranges from about 6 degrees for a geosynchronous transfer orbit to about 57 degrees for a true Molynia orbit. Pass times are 8 to 12 hours, and the footprint can be as big as half of the Earth at a given time. These footprints and pass times have obvious advantages over the LEO parameters if you like to “rag chew” and work DX. We were fortunate to have AO-10, AO-13, and AO-40 operational from HEO for a total of 20 years, between 1983 and 2003.

Unfortunately, we no longer have the luxury of any satellite in HEO. Furthermore, unless we can find a new way of raising funds, we are not likely to have any in the future even though Phase 3E is currently waiting on the shelf in Germany for an affordable launch to HEO.

GEO: The television relay satellites are the most common examples of Geosynchronous Orbit (GEO). A GEO satellite orbits the Earth at 36,000 kilometers (22,500 miles) in the plane of the equator (zero degrees inclination). With this magic set of orbital parameters the satellite will “hover” over a selected point on the equator at all times, and you can point your antenna at this satellite, lock down the angles, and use it 24 hours a day

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and 7 days a week. This would have definite advantages for amateur radio satellite use, but we again run into the "affordability" problem. Rides to GEO and even rent on a commercial transponder are extremely expensive. Several proposals have been made over the years for amateur radio GEO satellites, but we have never been able to raise the money required. Even with obvious advantages for emergency communications, we have thus far always fallen short of funds for a HEO satellite.

Operational Modes: FM Voice, SSB/CW, Digital, and Manned

FM Voice: FM satellites can be classified as repeaters in the sky. They are typically one or two channel repeaters in orbit and have the advantages of easy Doppler correction and vast and relatively cheap availability of ground-station radios. Disadvantages are crowding and very limited communication time due to the crowding. Visualize your favorite FM repeater located at 800 kilometers altitude over the center of the U.S. with a 3000-mile diameter footprint and think about how many hams are in the footprint. Multiply this by the FM "capture effect" (big signal always wins) and you get the picture. They can be a lot of fun for "grid-square chasing" and other forms of contesting. With proper discipline, they can be used for serious communications. Again, ground-station rigs are plentiful and cheap. Full-duplex operation is highly desirable but not a must. Special applications of Slow Scan Television (SSTV) are possible.

SSB/CW Linear Transponders: Satellites with linear transponders can be used with a multitude of communications modes, but they usually are used with SSB and CW. Most typical HF modes of operation are possible. These satellites have passbands that are typically 50 to 100 kHz wide and can accommodate multiple QSOs at one time. They repeat an entire uplink passband on the downlink passband. They may either invert or not-invert the passband frequency sense and mode. Each QSO gets a share of the available power and therefore contributes to the number of QSOs that can be supported. Only low-duty-cycle (low-power) modes are tolerated on these satellites. Ground-station radios must be capable of SSB or CW, and full-duplex operation is a must. Signal levels are typ-

ically weaker; therefore, pre-amps and higher gain antennas are desirable. The obvious advantage of these satellites is the multiple QSO capability which permits real conversations on the satellites.

Digital: Digital satellites usually are channelized and can be either FM or other

modulation types. They usually permit "store and forward" messaging and can be built to support several different modulation types and baud rates. Conventional 1200-baud AX-25 packet radio is still used to support APRS digipeating and messaging on the ISS. AO-51 and SO-32



SPACE DESIGNS — The National Aeronautics and Space Administration released these conceptions of configurations of space craft to giant step in space conquest early next month.

The National Aeronautics and Space Administration also said the next orbit attempt in the Mercury program will be made by a man—ruling out any more tests with animals.

Astronaut John H. Glenn Jr., 40, a Marine lieutenant colonel already has been chosen to take the ride, with Navy Lt. Cmdr. Scott Carpenter, 36, as the backup or standby pilot.

No firm December target date had been announced for orbiting the first American. But U.S. space officials for months had been pushing to accomplish it in this same year the Russians orbited their two space pioneers. Word had been passed that the attempt might be made as early as Dec. 20.

NASA officials set no specific January date, although there were indications here it might be in the first week of the new year. Unofficial sources at the Cape Canaveral, Fla., launching site reported a date of Jan. 18 had been picked.

No Explanation

There was no official explanation for the decision to wait until next year and the announcement was a surprise to most persons at Cape Canaveral.

There had been reports of technical troubles interfering with plans for an orbit this year, but NASA has insisted all is progressing normally. And officials at the Cape reported checkouts of the Atlas booster, the man capsule and other phases of the program are progressing smoothly.

However, officials at Cape Canaveral said a launch attempt this year would have put extreme pressure on everyone and this might have affected the success of the venture.

A NASA official here said it normally takes about six weeks to prepare for an orbit attempt and an early January date would just about give that much time since last week's orbit by Enos the chimpanzee. A 15-day technical delay in his flight had been a big factor in stalling hopes for a man-orbit this year.

he used in three separate phases of Project Apollo. Contract was awarded to North American Aviation Co.

'Hams' Track Orbiting Radio Robot 'Oscar'

VANDENBERG AIR FORCE BASE, Calif. (AP)—OSCAR, a 10-pound radio robot, is orbiting the world, heaping "hi" to radio hams from Byrdland, Antarctica, to Kodiak, Alaska.

OSCAR—short for Orbiting Satellite Carrying Amateur Radio—was launched Tuesday aboard a Discoverer satellite and about 90 minutes later was transmitting the four dots and two dots that spell "hi" in Morse code.

The Discoverer 36 satellite also carried its usual cargo—a capsule of secret instruments that will be ejected within a few days. The Air Force has planes ready to snag the capsule as it parachutes near Hawaii — a feat achieved seven times to date. Three other capsules have been fished from the ocean.

Most of the attention is centered on OSCAR—carried aloft in the rocket's tail in place of ballast. The capsule is in the nose cone.

OSCAR, the world's first satellite built entirely by private citizens, will transmit for about 30 days, or as long as its batteries last.

It was conceived and built by space engineers whose hobby is tinkering with short-wave radio. Project chairman M. C. Towns of Sunnyvale, Calif., said this was the first time a satellite has been transmitted on the international amateur frequency of 145 megacycles.

The Air Force has no official connection with the project.

Project sponsors say future OSCARs, if approved by the Air Force, could open up new lines of communications in national emergencies.

All the world's amateur radio operators — about 300,000 — have been invited to help track OSCAR.

OSCAR was ejected on Discoverer's first pass over the antarctic, the Air Force said, and was circling the globe every 91 minutes at an altitude ranging from 150 to 200 miles, slightly behind its mother satellite.

Chute Escape Capsule Passes Air Force Test

EDWARDS AIR FORCE BASE, Calif. — (AP) — The Air Force says it has successfully tested a method of parachuting a pilot to safety in a rocket-powered escape capsule.

Two man-sized dummies, each in a 700-pound steel capsule, were parachuted 12 seconds after being blasted about 250 feet up from a speeding rocket sled.

Monkey Shot Into Space

CAPE CANAVERAL, Fla. (AP) — A tiny Rhesus monkey named Scatback with a radio transmitter and medical instruments implanted in its body rocketed 600 miles into space Tuesday night and landed in the South Atlantic Ocean more than 6,000 miles southeast of here.

The Air Force reported 80 minutes after launching that the range vessel Sword Knot was in the impact area and was searching for the special cylinder in which the four-pound monkey rode.

Two search planes, also swept the area for a sight of the package.

Scatback was in a six-foot-tall capsule attached to the side of an Atlas missile which blazed away from Cape Canaveral at 10:32 p.m. Five minutes later the rocket's powerful engines shut down as planned and in another minute the cylinder ejected and followed a 15,000-mile-an-hour ballistic course much like the Atlas nose cone.

The cylinder impacted as planned about 1,000 miles southeast of Ascension Island. A buoyant bag was to keep it afloat.

—The Air Force abandoned to a turbulent sea Wednesday a small monkey named Scatback who rocketed 600 miles into space to pioneer techniques for human astronauts.

As the South Atlantic Ocean search was terminated, technicians studied signals radioed during the flight from a transmitter imbedded in the stomach of the four-pound animal. Analysis could help determine if surgically implanted medical sensors are feasible for future space pilots.

The range vessel Sword Knot combed the impact area for nearly 15 hours before darkness forced to an end the search in the area 6,000 miles southeast of Cape Canaveral.

Scatback thundered away from the cape at 10:32 Tuesday night in a 6-foot capsule tacked to the side of an Atlas missile. The Atlas performed flawlessly and unleashed the capsule on a 30-minute, 15,000-mile-an-hour ballistic course which put it right on target.

Two planes joined the search initially, but had to withdraw after three hours because they were low on fuel. Without aerial eyes to guide it, the Sword Knot faced a tough task in rough water where the waves were seven to nine feet high.

The was some feeling that the monkey-bearing cylinder sank shortly after landing. No signals were picked up from a radio beacon in the capsule nor were flashing lights attached to it sighted.

No Details Out On New Satellite

POINT ARGUELLO, Calif. (AP) — The Air Force says it launched a satellite Friday—but won't disclose any details.

It was launched at the Point Arguello naval missile facility, adjacent to Vandenberg Air Force Base.

The Air Force recently has been close-mouthed about launchings of so-called sky-spy satellites, designed to orbit over Russia and detect missile launchings and photograph military bases.

The satellite launched Friday is presumed to be a military spacecraft.

The Air Force's terse announcement said only that: "A satellite enjoying an Atlas Agena B booster combination was launched by the Air Force today at Point Arguello."

"It is carrying a number of classified test components."

The Air Force wouldn't elaborate on whether the launching succeeded in reaching orbit.

Satellites of the Midas and Samos sky-spy series sometimes are launched from the pad where the rocket roared aloft.

An OSCAR AP article from Vandenberg AFB about the launch of OSCAR-1. This came from a western Kansas newspaper (probably the Dodge City Daily Globe or the Hutchinson News) dated December 13, 1961. I have three scrapbooks that contain this and many other space program articles from newspapers in the 1950s, '60s, and '70s. They cover Sputnik through the Apollo programs. Given the media bias toward the spectacular, there are many more failures than successes reported; however, these were tough days and they may be close to accurate. My stepfather found these scrapbooks somewhere around Dodge City, Kansas and presented them to me for Christmas several years ago.

support 9600-baud FSK packet. AO-51 will accommodate faster rates as well. Operating systems can be optimized for store-and-forward messaging over several orbits if necessary. Future digital modes can be placed in this category as well.

Manned: Starting with the U.S. Space Shuttle we have had amateur radio operators in space. Equipment has been available on the Shuttle, the Russian MIR Space Station, and the International Space Station (ISS). Astronauts and cosmonauts have been licensed and trained to use this equipment for promotion of science, technology, engineering, and mathematics (STEM) in education; personal enjoyment; and backup communications. Currently, the ISS has made over 500 school contacts to support STEM, and several of the astronauts have provided many other manned space contacts to the general ham population. Unfortunately, the astronauts/cosmonauts have a heavy workload and priorities on their personal time are up to them. Some are much more interested in ham radio than others. Modes such as digital television on L and S bands are in the planning stages. Antennas are already in place on the ISS for this.

Frequencies Used

Satellite operational modes are often confused with combinations of uplink and downlink frequencies. For example, Mode A means a 2-meter uplink and a 10-meter downlink, Mode B means a 70-cm uplink and a 2-meter downlink, and Mode J means a 2-meter uplink and a 70-cm downlink. We are in a transition phase with a new terminology: Mode B is being replaced with Mode U/V (Mode *Uplink Freq. Band/Downlink Freq. Band*). U band is UHF and V band is VHF. Mode J becomes Mode V/U. This is being done to permit transition to more combinations on the newer satellites. AO-51 supports Modes V/U, V/S, L/S, and various sub-modes within these designations. Sub-modes are usually various modulation types. Again, AO-51 can support SSB/CW on the uplink with a FM downlink in several modes. Most of the time modulation type is FM uplink/FM downlink on its modes. A complete study of all of the possible uplink/downlink frequencies and modulation types is beyond the scope of this article, and I recommend a study of the charts on the AMSAT web page. A review of the *Satellite Handbook*, *Getting Started on Amateur Radio Satellites*, and other publications is also helpful.

The most common frequency pairs used are V/U and U/V; however, a move higher and higher in frequency is the trend. After all "use it or lose it" is still alive, and smaller satellites such as the CubeSats definitely mean higher frequencies to fit the available real estate on the "bird."

Ease of Use

Working the amateur radio satellites is not difficult, but some are more challenging than others. For all satellites, you will need to know when it is above the horizon at your location, what uplink and downlink frequencies are involved, and what type of satellite it is—FM voice, SSB/CW, digital, or manned. If you are using directive antennas, you will also need to know where to point them. In these days of the internet, all of this information is available on the AMSAT web page in one form or another. Orbital pass time and pointing angle information is available from an on-line tool. Frequency and mode information is also available on the web page.



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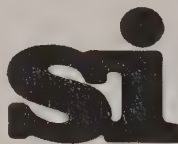
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Keplerian data for your own tracking program is available for its use in generating the pointing information. Tracking programs are available through the AMSAT store. These programs can also be used, with proper interfaces, to control your antennas and/or your radios. All of these software controls are nice but not necessary for your first enjoyment of working the satellites.

As mentioned earlier, radios for the FM voice satellites are more commonly available and less expensive. You can use either a dual-band VHF/UHF radio or separate VHF and UHF radios. Some of the older radios may have to be "opened up" to cover all of the frequencies, particularly the UHF radios.

Multimode radios suitable for the SSB/CW satellites may also be of the single-band or dual-band variety. Several new and used single-band and multi-band, multimode radios are still on the market. Some of these even have HF and microwave capabilities. Like many other facets of amateur radio, you can spend as little or as much as you want. Another relatively cheap alternative, if you already have HF equipment, is the use of outboard up and down converters attached to your HF gear. Combinations of relatively inexpensive multimode, multi-band equipment such as the Yaesu FT-817 and FT-857 transceivers, your computer, and a SatPC32 Tracking Program can be used very effectively along with steerable antennas for a deluxe station at a fairly reasonable price. Steerable antennas, antenna rotors, and rotor interfaces are available to round out the deluxe station.

Of course, the simplest and most inexpensive station is a dual-band HT with a hand-pointed directive antenna. This antenna can be homebrewed or purchased from Arrow Antennas or Elk Antennas. A 5-watt, or less, radio will work with enough patience, skill, and cunning. This is usually an FM voice station, but SSB/CW variants are also possible.

One other topic—Doppler tuning. This is necessary on all of the satellites, especially the UHF side of the station. It can be done manually with the aid of frequency steps and radio memories, or automatically with your radio interfaced to your computer and tracking software. It is absolutely essential on both the uplink and downlink of the SSB/CW satellites and at least on the high-frequency component (usually the UHF side) of an FM voice satellite.

All of this may seem complicated, but take it a piece at a time, understand it, practice it, use it, and it will become second nature. By the way, there is nothing quite like the thrill of your first successful satellite contact!

Summary

Follow the above guidelines and join us in the amateur radio satellites part of the hobby. Don't be overwhelmed by the perceived complications. Break them down to their simplest form and join the crowd.

Follow this column for up-to-date information on all of the amateur radio satellites and related topics.

Please continue to support AMSAT in its plans for the future of the amateur radio satellites. AMSAT is now updating its web page at <http://www.amsat.org> on a much more regular basis. Satellite details are updated regularly at <http://www.amsat.org/amsat-new/satellites/status.php>. 'Til next time . . .

73, Keith, W5IU

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ATV

Amateur Television – Methods and Applications

Digital Modulation and Signal Processing in ATV

Digital signal processing is certainly a hot trend in voice communications. Analog television can be vastly improved by the use of digital signal processing. There are many application-specific integrated circuits (ASICs) available, such as the Analog Devices ADV7181, that allow for analog signals to be converted to the digital domain and have properties such as gamma or hue of the video be adjusted or corrected. Additionally, we could easily add an on-screen display in the digital domain, convert between different video formats (NTSC, PAL, SECAM), or take a variety of inputs (Composite, Component, S-Video, VGA, etc.). In all of these cases, nearly all the work of processing and converting can be accomplished by a single chip that has already been manufactured.

Once we get the signal into the digital domain, we can also use digital methods to modulate the signal. This has many advantages, one of which is flexibility. A nearly identical digital system could be used to modulate an analog signal or a digital ATSC signal. Thus, we could have a system that could take a variety of inputs and give us output in the form of a standard ATV signal or a D-ATV signal.

Another great advantage of digitally modulating the signal is that it can reduce the number of components, saving both cost and space in a design. It is difficult to deal with a digital signal that can be directly converted to the 70-cm (or higher) band, as this would require clock rates nearing or exceeding 1 GHz. Instead, we can produce base-band signals around the range of 30 MHz and then upconvert them to the desired band. This also makes our design very easily frequency agile, which is why we typically use base-band frequency levels to modulate and demodulate analog signals.

Television uses a modulation method called *vestigial-sideband (VSB) modulation*. Constructing a vestigial-sideband

signal is very similar to constructing a single-sideband signal. In the case of vestigial-sideband, we are taking the entirety of one sideband and a portion (vestige) of another. There are two primary reasons why we do this. First, a television signal, unlike a voice signal, nearly needs the DC components to accurately reconstruct the image. Thus, there is no clear distinction between sidebands and it becomes very difficult to separate them. As a result, we take part of the lower sideband along with the upper sideband. Another reason we use vestigial-sideband modulation is that it allows a portion of our carrier signal to be sent. Anyone who has operated SSB voice knows that it is difficult to tune to

the exact frequency to hear the transmitted voice at the correct pitch. When operating voice, it is acceptable to be slightly off frequency, as the speaker's voice is still intelligible; however, demodulating a video signal slightly off frequency would cause unacceptable problems. By allowing a portion of our carrier to be transmitted, the receiver can accurately lock on to the transmitted signal and properly demodulate the signal.

As with single-sideband, there are generally three methods to create a vestigial-sideband. Each method offers advantages and disadvantages depending on the type of signal modulated and the architecture of the system. The three methods that will

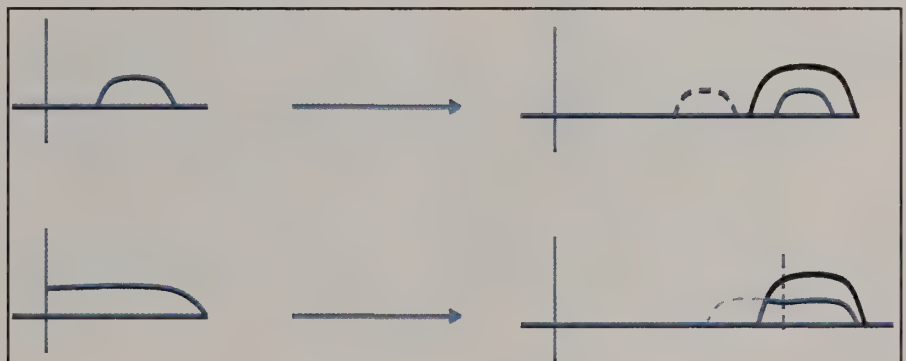


Figure 1. A voice signal, in the top left, is modulated by a carrier. One of the resulting sidebands is selected, and we get a SSB transmission. A video signal, on the bottom left, is modulated by a carrier, but it is not so simple to select a single sideband due to the wide bandwidth of the video signal. Hence, we use VSB.

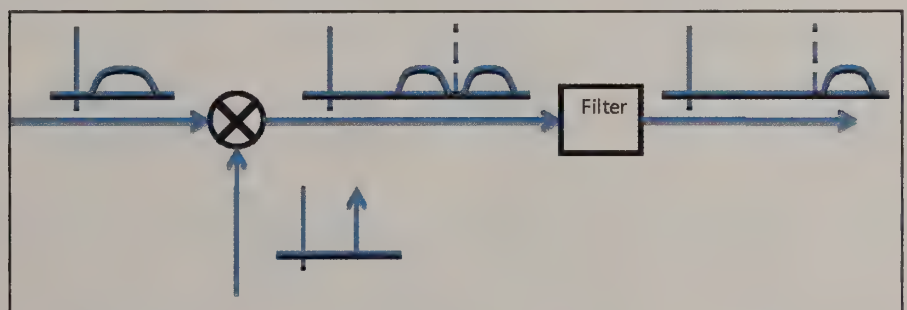


Figure 2. The Filter method. A signal is modulated by a carrier, and one of the sidebands is eliminated by a carrier. This is the simplest method of creating SSB or VSB but does not work so well in the digital domain.

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be described are: the filter method, the Hartley method, and the Weaver method.

Filter Method

The filter method is the method with which many amateurs may be familiar, as it is the simplest and most easily implemented in analog hardware. In this method, the signal is modulated with a balanced mixer, which results in a double-sideband signal with a suppressed carrier. From here the signal is passed through a filter which selects one of the sidebands to be transmitted.

Transmitting television signals requires very precisely defined filters. Unlike modulating a voice signal, with a television signal we must filter both the upper (to limit the bandwidth of the video signal) and lower (to transmit only a part of the lower sideband) portions of the signal. Thus, we require a band-pass filter. Such a filter could be realized in many ways in an analog system. It is common in video systems to use surface acoustic wave (SAW) filters, which are somewhat similar to mechanical filters in that they offer a relatively small package, sharp cutoffs, and high efficiencies and stabilities.

This straightforward system introduces a slight problem in the digital domain. In order to create the necessary filters, we would need to have a very large number of taps (digital filter elements) at a very high sampling rate. While this brute-force method may be possible with a high-density FPGA, we can design a system in a much more eloquent way.

Hartley Method

Another method that can be used to modulate a single, or vestigial, sideband signal is the Hartley method. This method is not as commonly used in analog systems, as it requires matching two signals closely in phase and amplitude to fully suppress a sideband. In order to modulate a signal using the Hartley method, we take the original signal and shift a version of it 90 degrees in order to create an in-phase and quadrature version of our original signal. We then mix the two signals with an in-phase and quadrature version of our carrier and sum the resulting signals together. This will result in a single-sideband signal (for a mathematical treatment of the Hartley method, see "The Hartley Modulator"¹).

In order to create a vestigial-sideband signal using this

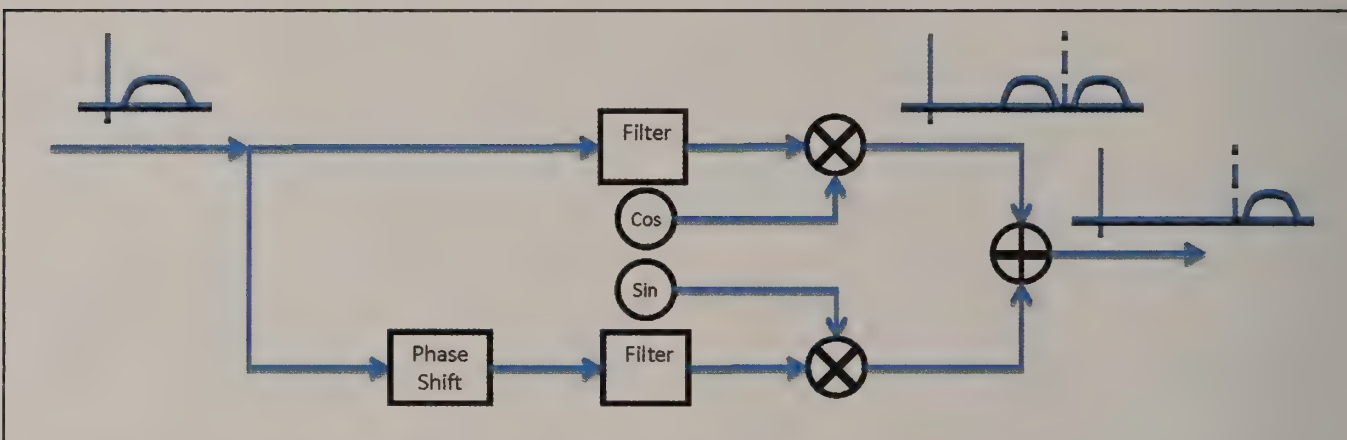


Figure 3. The Hartley method. In this method, phasing is used to cancel out one of the two sidebands. Filtering can be used in order to achieve VSB rather than SSB. This method is impractical with a video signal, because it is impossible to phase shift the near DC components of the video signal.

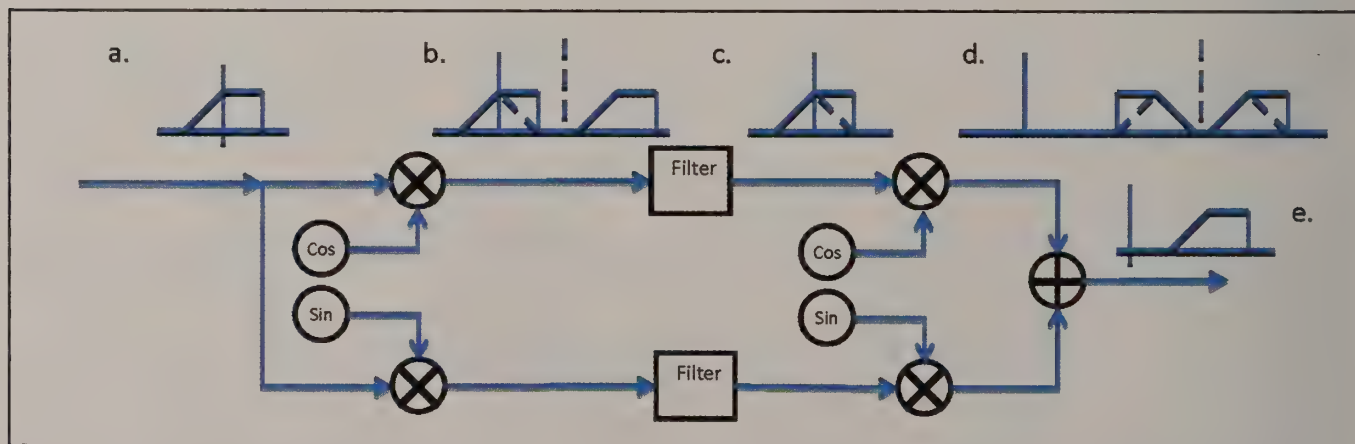


Figure 4. The Weaver method. This is the preferred method in digital modulation. In this method a signal (a) is mixed with a low-frequency carrier resulting in (b). (b) is then filtered to give (c), which is mixed with the RF carrier to give (d). The result of phasing yields only one sideband as shown in (e). This method is difficult to implement in the analog domain but solves the problems of the previous methods.

method, we can filter the signals after they have been phase-shifted but before they are mixed with the carrier. This solves the previous issue of having complicated filters. However, there is one primary difficulty with this method that is present in both analog and digital implementations. The 90-degree phase shift of a signal is often referred to as a *Hartley Transform*. The Hartley Transform can very feasibly be implemented in a narrowband signal such as a voice signal. However, with a wideband video signal, we do not get a very uniform frequency response and we require a large amount of equalization. Although this complicates our design, it is still feasible to perform this equalization, especially in the digital domain. We do run into a larger, but related problem: It is impossible to phase shift a DC signal. This creates a theoretical low-frequency limit to the signal that we modulate. It is still possible to create the needed signal if we reinsert the carrier and carefully study the needed equalization, but it quickly becomes more complicated. There is a third method of modulating our signal which will solve this problem as well.

Weaver Method

The Weaver method is sometimes referred to as the "third" method of single-sideband modulation. This method is very difficult to implement in the analog domain, because it is extremely sensitive to mismatches in filters and signal paths. This problem is trivial in the digital domain, as we do not have tolerances of components with which we have to deal. The Weaver method is the least intuitive method and possibly the most difficult method to understand; for a mathematical treatment of this method, see *The Weaver Modulator*.²

When we modulate a signal with the Weaver method, we mix the original signal with both in-phase and quadrature versions of a low-frequency carrier. When we do this, we choose a low frequency that allows our negative frequencies to overlap with our original positive frequencies. When we mix the in-phase and quadrature versions of the resulting signals with two carriers that are 90 degrees out of phase, we end up with one of our sidebands cancelling out.

Creating a vestigial sideband is simple. All we have to do is choose a slightly lower frequency for our first frequency and only a portion of our negative frequencies will overlap with the positive

frequencies; as a result, only a portion of one of our sidebands will be cancelled out! All of our filtering can be done after the first low-frequency carrier is mixed in, and we only need to use low-pass filters. This greatly saves on the complexity of our filter design. Additionally, multiplication of signals with the carriers is extremely simple in the digital domain, as we simply can use sequences of 1's and -1's and we will end up with a signal that can be accurately be reconstructed in the analog domain. Even though this method is much less straightforward, it is clearly the simplest to implement in the digital domain.

Conclusion

Modulating a video signal with the Weaver method can allow us to modulate either a digital or analog signal to a baseband frequency using a common architecture. With typical reprogrammable

digital devices, this baseband signal could easily be in the range of 30 to 60 MHz (or greater). Once we have a baseband VSB signal, we can mix it with a carrier that could be created by a variable frequency oscillator (VFO) and pass it through a relatively simple low-pass filter to get our video signal at the band and frequency (or channel) that we desire. Such an architecture would allow us to harness the power of digital signal processing for video signals and would provide us with great flexibility in terms of input formats for our video.

73, Thomas, KB1JIJ

Notes

1. The Hartley Modulator: <<http://soe.unn.ac.uk/ocr/teaching/ppp/SSBSC/sld006.htm>>.

2. The Weaver Modulator: "A third method of generation and detection of single sideband signals," Weaver, D. K., *Proc. IRE*, Dec. 1956, pp. 1703-1705.

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

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Pitfalls in Helix Antenna Construction

Perhaps the VHF antenna with the most misconceptions, old-wives tales, and just plain wrong information is the helix antenna, such as the NASA tracking array shown in photo 1.

There are a lot of helix calculators on the internet and the text-book equations going back to J. D. Kraus, W8JK's original formulas. However, it is generally agreed that these tend to be 3–5 dB too optimistic at predicting the gain of a helix antenna.

I am not saying you can't build a good helix antenna. I'm just saying it's a lot harder to build a good one than most hams think. At various conferences we have tested nearly 100 helix antennas built by different hams on my semi-portable antenna range. Only about one in five had forward gain and was circularly polarized, and here is how the other four out of five went wrong.

Velocity Factor

A radio wave traveling down a wire travels at about 95% the speed of light. The common equations for a dipole antenna take this velocity factor into account. Light slows down when it is traveling through a medium such as glass or plastic—after all,



Photo 2. Helix antenna wound on plastic pipe.

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Photo 1. NASA tracking array.

this is how a lens works. Take the common 66-foot, 40-meter dipole. If you build it out of bare copper wire, it will have the lowest free-space SWR at 7.25 MHz. Now build that same 66-foot dipole using insulated wire, and the new SWR minimum will be 6.77 MHz. That thin layer of plastic has moved the resonant frequency down almost .5 MHz, and you have to shorten the dipole about 4½ feet to bring it back to 7.25 MHz.

Note: I have lowered the frequency of a small Yagi just by putting heat-shrink tubing over the elements. Yes, if you cut an element a bit short, you can electrically lengthen it with plastic tubing or heat-shrink tubing.



Photo 3. Short helix for use as a dish feed.



Photo 4. More helix antennas wound on plastic pipe.

Back to the dipole example. The dielectric constant, or ϵ_r , of the insulation is usually not controlled at the wire factory. Mechanical strength, viscosity, voltage breakdown, and other mechanical factors are tightly controlled, but not ϵ_r . As hams we can get close, build the antenna a few feet long, and then trim back for best SWR at our favorite frequency, so this isn't a big deal.

Now let's look at a helix wound on a piece of sewer pipe, such as the one shown in photo 2. Again, the ϵ_r of the plastic is not controlled. Call your local hardware store and ask for the dielectric constant of its plastic pipe. I'm sure you will get the "deer in the headlights" response. So get clever and dig out your *CRC Handbook of Chemistry and Physics* or do a quick internet search on the dielectric constant of PVC plastic, and you will get various numbers around $\epsilon_r = 3.2$ for the dielectric constant.

Again, ϵ_r is not a controlled number during manufacturing, and even worse, the ϵ_r of most materials changes with frequency. That 3.2 value was probably measured at 1 kHz, not 2.4 GHz!

Here is where the textbooks and internet calculators lead you astray. The textbooks are calculating a free-space helix antenna. When a metal strip is wound on the plastic, you have a new velocity factor for that line. With most plastics this new velocity factor is about 60% of the

free-space value. That is, the signal is traveling along the turns of the helix only about 60% as fast as the formula/calculator assumes it is traveling. This really messes up the turns ratio of the helix. I am not saying you can't compensate for this 60% velocity factor with a new helix design, but plan on building a pile of prototypes and using a lot of test equipment. Then buy a lot of the plastic pipe, because the odds are that sewer pipe from another

vendor or a different manufacturing batch will need different dimensions.

Testing a Helix Antenna

Many years ago the original designs for OSCAR Phase 3D, the bird that ultimately became AO-40, called for several helix antennas on a spin-stabilized platform looking back at the Earth. I was sent several of these helix antennas for gain testing. Oh, did I have problems getting a good consistent reading. You see, while a helix has forward gain on a VHF or UHF frequency, lower down it looks like a *big rubber-ducky*. That 1269-MHz helix was also a quarter-wave whip on TV Channel 4, and of course my antenna range is about 5 miles from a TV Channel 4. In high RF environments, a helix antenna looks like a long wire antenna. Your equipment just might need extra filtering to avoid overload from nearby transmitters even though they are on a much lower frequency.

The Short Helix as a Dish Feed

A two- or three-turn helix has often been used as a simple dish feed such as the one shown in photo 3. The problem is getting circular polarization from only a few turns of wire. Most of the time a short helix comes out more linear polarized than circular. If you test a short helix on the antenna range against a linear antenna, you typically see about a 10-dB change in gain as you rotate the antenna while pointed at the source. A Yagi typ-

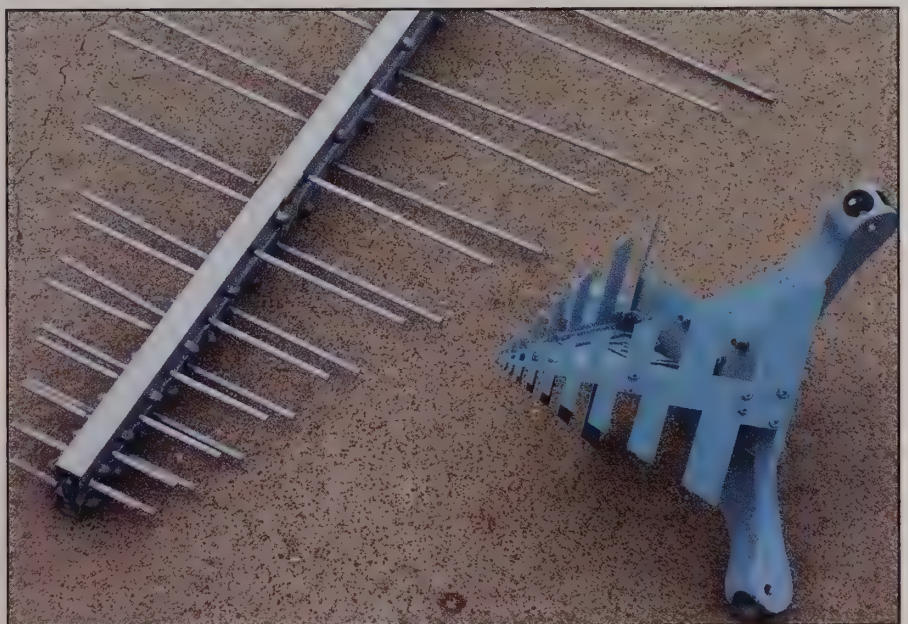


Photo 5. A log-periodic dish feed.

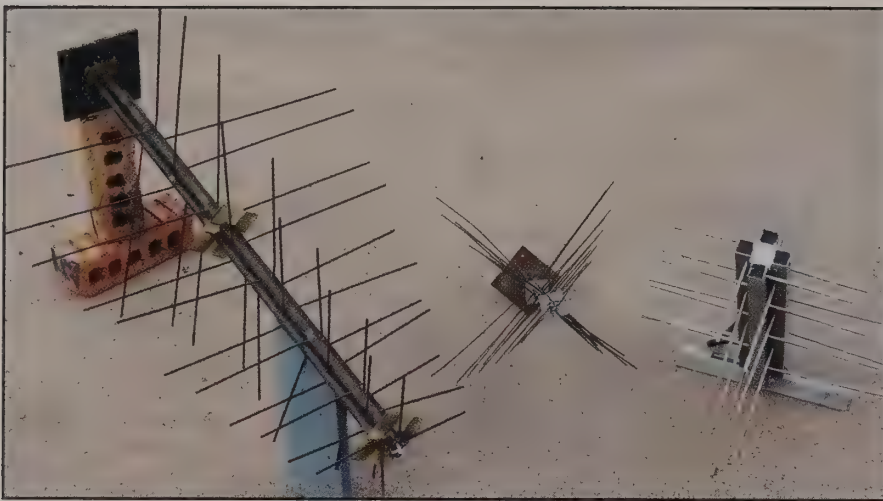


Photo 6. Circularly polarized log-periodic antennas.

ically has about 20 dB of change when you rotate its polarization. A good circularly polarized antenna will have less than 1 dB of variation when rotated. Just trimming a fraction of an inch off the end of the helix can make a drastic change in the polarization of the helix.

With careful trimming, expanding and compressing the helix, there is a magic spot where you will have a good SWR and good circularity. It's in there, but without test equipment the chances of randomly hitting it are not good.

The helix antennas wound on plastic pipe in photos 2, 3, and 4 all came from an RFID (radio-frequency identification) company developing 2.45-GHz RFID tags. While intended for 2.45 GHz, and

carefully adjusted for best SWR on very high-dollar test equipment at 2.45 GHz, they actually had maximum gain between 2.15 and 2.2 GHz. Much of their performance issues in the field tests were apparently not in their RFID tags.

Log-Periodic Antennas as the Dish Feed

The active area of a log periodic moves as the frequency changes. The high frequencies radiate from the front of the antenna; the low frequencies radiate from the back of the antenna. So which part of the log periodic do you mount at the focus of the dish?

In photo 5 we have a log periodic

designed to be used as a dish feed. Note the "squashed" or compressed look for this dish feed compared to a more typical log periodic. The highest frequency of the log periodic comes off the short elements at the front, and the lowest frequency of the log periodic comes off the longer back elements. The compressed style keeps more of this 1–10 GHz antenna at the focus of the dish.

Yes, a circularly polarized log periodic is possible, such as the ones shown in photo 6, but they are not a simple project. They also are a problem to store—one reason why these look a bit bent. You can't set them down without bending something. I hang these from the ceiling and try not to walk into them too often.

I have gotten some comments on all the unusual antennas of which I have photos. Most come from years of collecting unusual antennas. Last week I stood in the attached garage and counted 192 antennas. The troubling part is I was standing in only one place, looking only at the top layer, and not even counting the back garage or the storage building!

The Bottom Line

Suspending the helix on spokes from a central support, keeping all other materials near the helix to a minimum, and doing it like NASA did 50 years ago (photo 7) is the way to make a helix antenna. If someone has an optimized and tested design, do not change materials or dimensions. Even using a different wire diameter or different insulating materials will affect performance.

A Plug for a Special Conference

The 14th International EME Conference will be held on the north edge of the Dallas/Forth Worth (DFW) airport from August 12th to the 14th. An excellent slate of speakers will be assembled for this cutting edge aspect of ham radio. For more information, contact me at <wa5vjb@cq-vhf.com> or Barry Malowanchuk, VE4MA, at <ve4ma@shaw.ca>.

Finally

As always, our readers are one of the best sources of ideas for future antenna projects. Any antenna questions or antenna projects you would like to see, just drop an e-mail to <wa5vjb@cq-vhf.com>, or visit <www.wa5vjb.com> for additional antenna projects.

73, Kent, WA5VJB



Photo 7. A helix antenna the way NASA likes them.

UP IN THE AIR

New Heights for Amateur Radio

New Heights for Science Fairs

Eighth grade student Jodie Tinker of Huntsville, Alabama wanted to take her science fair project to new heights. She decided to research the use of weather balloons to study the atmosphere and to ultimately take photos and videos from the very edge of space with her own balloon camera payload (see photo 1).

Stephanie Long and Wes Cantrell, with the support and encouragement of Dr. Newchurch of the National Space Science and Technology Center's (NSSTC) ozonesonde program, took her under their wings and taught Jodie how to prepare an ozonesonde payload. She participated in a number of the weekly launches of their ozone sounding balloons and learned how this data helps monitor the ozone layer and its impact on the environment.

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e-mail: <wb8elk@aol.com>



Photo 1. Eighth grade student Jodie Tinker with her video camera payload. (Photo by WB8ELK)

I helped introduce Jodie to amateur radio high-altitude ballooning and how to use Automatic Position Reporting System (APRS) to track and recover balloons. A good portion of her final display was dedicated to amateur radio and APRS.

Jodie did some research and came up with a new camera that had never been flown before in near space. It's called the Tachyon XC helmet cam (www.tachyoninc.com) and is designed to mount on the helmets of extreme-sports enthusiasts. It has some very nice features, including the ability to start it up via an infrared (IR) remote control. This feature is very handy in that you don't have to pop open a payload lid or retape anything just prior to liftoff. Just point the remote control at the camera lens and it gives you an audible beep acknowledging that it's recording.



Photo 2. Jodie and her balloon inside the NSSTC highbay. (Photo by WB8ELK)



Photo 3. Liftoff of Jodie's balloon. (Photo by Alan Sieg WB5RMG)

The Tachyon XC has a number of additional features that are hard to find in many consumer-grade digital camcorders, which makes it quite useful for BalloonSat flights: The Tachyon can handle up to 32 GB SDHC memory cards to allow 8 hours of recording time. No special battery pack is needed; you can run this on two lithium AA batteries. You also have the option of putting the camera into a Time Lapse Photography mode that takes a still-frame photo every 2 seconds.

Video Cam Flight

Jodie's first flight was in February. She put her camera experiment into video mode for this mission. The jet stream winds were fairly high and the balloon quickly headed towards north Georgia. None of our usual balloon trackers were available that weekend, so I stayed behind after the launch to be Mission Control and guided Jodie and her father, Mike Tinker, towards the predicted landing zone via our cell phones. Jodie was very lucky on this flight, as the payload landed a few feet from a small road near Dalton, Georgia. Rugged mountains are on either side of this valley and her balloon managed to land right in the middle of the flat area in between. Using Google maps displaying APRS data on <www.aprs.fi> and <www.findu.com>, I was able to guide them onto the right road near the landing spot. I could hear Jodie's excitement over the phone as they approached and spotted the parachute and payloads. They just stopped the car, grabbed their experiment and the tracking equipment, and headed back home. Of course, all BalloonSat recoveries are this easy ... not!

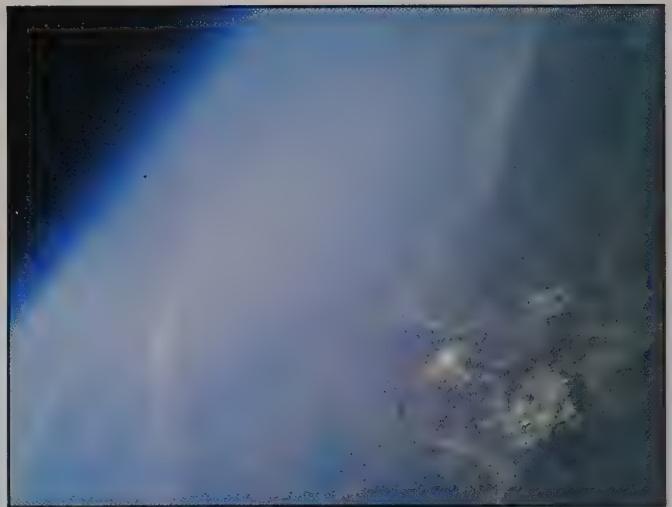


Photo 4. 95,000 feet above Chattanooga, Tennessee. (Photo by Jodie Tinker's near-space camera)

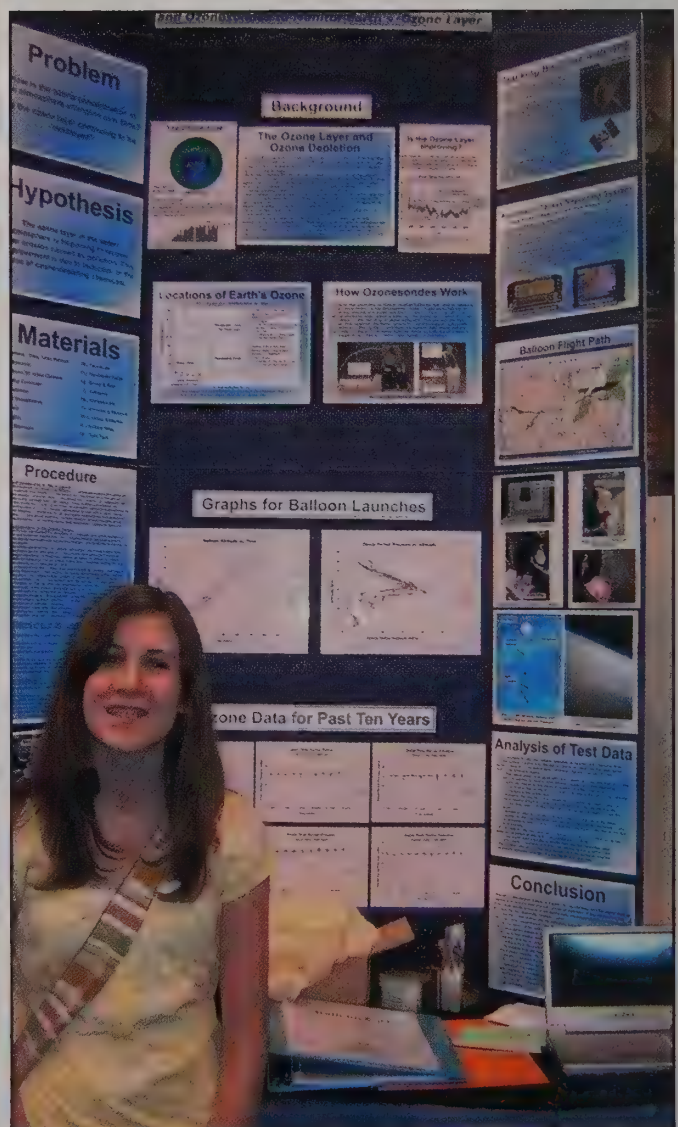


Photo 5. Jodie wins her category at the Alabama State Science Fair. (Photo by Mike Tinker)

The amazing video she recorded during this flight helped her to win the regional science fair a few weeks later. She decided to add to her display by doing yet another flight to prepare for her State Science Fair competition.

Thousands of Near-Space Photos

This time Jodie put her camera in the time-lapse still-photo mode. The still frames are not as high resolution as a dedicated digital still camera, but they are still quite remarkable.

It was a beautiful, clear day in late March, but the surface winds were quite breezy (good kite-flying weather). The UAH (University of Alabama, Huntsville) Space Hardware Club flew right before Jodie's flight so this time we had a full contingent of balloon trackers available. The SHC liftoff was quite exciting as their balloon nearly hit the ground several times just prior to liftoff. Fortunately, the winds died down a bit for Jodie's launch and went off without a hitch (see photo 3).

The Space Hardware Club flight landed near Chattanooga and was a fairly easy recovery. However, Jodie's balloon

decided to make up for her previous flight's incredibly easy recovery and landed on top of a heavily wooded ridge line near Cleveland, Tennessee. It was a few hundred feet from a road that was only passable by a pickup truck. Fortunately, Jason KG4WSV, Gary, N4TXI, and several students from the UAH Space Hardware Club came to her rescue as Jodie and her dad did a visual search in the woods and recovered her payload by tracking the APRS and DominoEX beacon transmitter.

We Have a Winner

After a two-hour flight taking a photo very two seconds, Jodie had thousands of photos to sort through. The results were quite beautiful. In photo 4 you can actually see part of east Chattanooga, Lovell airfield, as well as Interstate highway 75 from the vantage point of 95,000 feet above the earth. The curvature of the Earth and the blackness of space are quite evident.

How did Jodie do in the Alabama State Science Fair? She won first place in her category and ten additional special awards at the competition (see photo 5).

73, Bill, WB8ELK

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	(10 or more)	\$2.40 ea.
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UG-21D/U	N Male RG-8, 213, 214 Delta	4.75
9913/PIN	N Male Pin for 9913, 9086, 8214	
	Fits UG-21 D/U & UG-21 B/UN's	1.50
UG-21D/9913	N Male for RG-8 with 9913 Pin	5.00
UG-146A/U	N Male to SO-239, Teflon USA	8.50
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Announcing:

The 2010 CQ World-Wide VHF Contest

Starts: 1800 UTC Saturday, July 17, 2010

Ends: 2100 UTC Sunday, July 18, 2010

Rules Summary

Bands: 50 MHz (6 meters); 144 MHz (2 meters)

Categories:

Single-Op All Band

Single-Op Single Band 6 Meters

Single-Op Single Band 2 Meters

Single-Op QRP All Band (<10 watts)

Hilltopper (SOAB QRP Portable limited to 6 continuous hours operating)

Rover (1 or 2 ops mobile/portable operating from 2 or more Grid Locators)

Multi-op

QSO Exchange: Maidenhead Grid Locator to 4 digits (e.g., FN41)

Multipliers: Total number of different Grid Locators worked *per band*.

Scoring: Work stations once per band regardless of mode. Count 1 point per QSO on 50 MHz and 2 points per QSO on 144 MHz. Total QSO points × Multiplier = Final Score.

Rovers only: Final score = Sum of QSO points from each

Grid Locator visited × sum of different Grid Locators worked from each Grid Locator visited.

Awards: Certificates are awarded to high-scoring stations in each USA state, Canadian province, and DX country in categories with outstanding effort. Rover certificates are awarded on a regional basis.

Club Competition: Credit your club for aggregate club score. See <<http://www.cqww.com/clubnames.htm>> for a list of registered clubs. Follow directions for registering your club if it is not already listed.

Log Submissions: Cabrillo formatted logs via e-mail attachment to <cqvvhf@cqww-vhf.com> with subject line Callsign (used in the contest) only. It is *strongly recommended* that paper logs be entered online via "Web Form for Typing in Paper Logs" link at <<http://www.cqww-vhf.com>> or postmarked by September 1, 2010 to: CQ VHF Contest, 25 Newbridge Rd., Hicksville, NY 11801 USA. Callsigns of electronic logs received are posted on: <<http://www.cqww-vhf.com>>.

Complete Rules: Complete rules for the contest are in the June issue of CQ magazine, on the CQ website <www.cq-ammateur-radio.com>, and at <<http://www.cqww-vhf.com>>.

BEGINNER'S GUIDE

All you need to know but were afraid to ask . . .

Go For It! Ham Radio . . .

Have you ever been to the Dayton Hamvention®? No? Well, you really need to go, at least once. Each year in mid-May, Dayton, Ohio hosts the equivalent of Ham Radio Mecca, a place to go and find out what's new, what's happening in the world of ham radio, renew acquaintances of the past and make new friends for the future. To be sure, the Dayton Hamvention® is a "must" for any and all ham radio operators.

I was at the CQ Communications booth at Dayton last year and noticed a young man standing back from the herd of inquisitive hams moving along the front of the booth, all asking questions and looking over the collection of publications on display. Obviously, this person was a ham radio newbie, judging by his demeanor and hesitant actions. He looked to be in his mid-teens, well built, athletic, and well groomed.

Finally, he worked up the nerve to approach the booth. I asked the obvious question: "Did you just get your license?" He nodded in the affirmative. In an attempt to get him talking, I asked about how he got interested in ham radio.

"My dad and my grandfather are both hams and I figured that I better not let the family tradition die," he replied.

"Great! So how did you go about getting your license? Work with the local ham radio club?" I queried.

"No, my mom helped me work through the Technician license exam at night, after dinner," was his reply. He added quickly, "Dad is in Afghanistan for his third tour of duty, so it was just mom and me. She knows as much about radio as I do."

"Wow! It sounds like your dad is in the military," I said.

"Yes, sir, he is in the Air Force. He is a Pararescue Jumper," he replied.

"A PJ, huh? Great bunch of guys. I have known several during my time in the Air Force," I offered.

"Do you know about PJs?" he eagerly countered.

"You bet. Went SCUBA diving in the

Azores with a couple of them, a great bunch of folks. The type you want taking care of you on the battlefield," I replied.

I saw his eyes light up at my mention of the term "PJ," and I knew I'd made a friend. In continuing to talk with him I found out that his name was Jay. He was 16 and played varsity football and was on his high school swim team.

It seemed that Jay wanted to get his ham ticket in preparation for college, with a thought toward becoming involved with the MARS (Military Auxiliary Radio System) program. In continuing our conversation it became apparent that Jay missed his father tremendously and was immensely proud of him and his work as a USAF equivalent of a battlefield doctor.

USAF PJs are part of the special operations division of the Air Force and are several steps above the average medic in training and ability. PJs are the folks who accompany special operations (unconventional warfare: Green Beret, Navy SEALs, etc.) operators into battle and are responsible for taking care of the wounded. Trained to the level of most General Practitioners in the civilian world, USAF PJs are the people who treat and stabilize the wounded and get them ready to med-evac to a field hospital. All in all, the USAF PJs have a sterling record. Their motto: "So that others may live" says it all. I could tell that Jay was very proud of his dad.

My new-found friend and I continued our chat for another 20 minutes. Jay told me that after coaching from his mom, they contacted a local amateur radio club in his area and took the Technician test, which he passed with flying colors. Although no longer required by the FCC, Jay had committed himself to learning the Morse code because both his dad and grandfather had passed the CW requirement back in their days. Not one to be left out of the loop, Jay, and his mom, dutifully studied CW and proudly confessed to me that he could copy a solid 15 wpm with no errors! I was duly impressed.

Why is it that *after* the FCC drops the CW requirement for obtaining a ham license do so many people learn Morse? Weird ... just plain weird! Then again,

I told Jay that I would meet him in about an hour and we would continue our conversation.

Thinking back on my early days as a newly licensed Novice Class ham, it was a wonder that I ever got on the air at all! Thankfully, I had the help of four "Elmers," folks who took the time and made the effort to help me with the various challenges encountered with getting on the air and making those first crucial contacts.

I fully understood Jay's dilemma, remembering my early days in the hobby, way back in the mid-1960s. Yes, there were radios back then! To tell the truth, I could not have gotten on the air as a Novice in 1963-64 had it not been for George Comstock, W7CJ, Mel Syms, W7CIS, and Jessie and Mike Brabb, K7TWS/K7TWR. I was very fortunate to have four Elmers who were always a phone call away to help me sort out the daunting task of setting up a shack.

The most notable problem in my early amateur radio career occurred when the FCC monitoring station in Livermore, California, 1500 miles south of my eastern Washington QTH, sent me a "pink slip" stating that they copied me working 80, 40, and 20 meters simultaneously! Thanks to the efforts of George, W7CJ, who helped me troubleshoot my Knight Kit T-60 transmitter, I got the rig all tidied up and back on the air, sans harmonics!

One thing that many of us who have been in the ham radio hobby for a while tend to forget is that newcomers to our hobby do not necessarily have a lot of the technical and operating information needed to successfully get on the air and operate. It is up to us, the current crop of "Elmers," who need to be proactive and help the "Jays" of the hobby.

I found Jay about an hour later waiting for me at one of the food venues at the HARA Arena complex at Dayton. We picked up a hot dog, some onion rings, and a couple of drinks and proceeded to talk ham radio for the better part of an hour. I was truly impressed with him. Here was a kid who actually wanted to study for and pass a test to get on the air and talk to the

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world via ham radio. We say that amateur radio is an "old -person's hobby." We need more "Jays" in our ranks.

Jay proudly showed me his newly acquired hand-held transceiver (HT), wondering if he'd made the right choice. I pulled my HT off my belt and handed it to him. He immediately noted that my HT and his were identical! I told him that a dual-band HT was just great in today's ham radio world. The extra flexibility offered by a dual-bander offset the small increase in price. Likewise, should he be inclined to get involved with emergency communications (EmComm) and become active with the local ARES/RACES chapter, he was ahead of the game with his new dual-bander.

Over the course of the remainder of our conversation we discussed clubs, Elmers, and the gathering of information necessary to function in today's amateur radio world. I also told him that for things that are rapidly changing, the basics and history of ham radio, ongoing activities, and more, there is nothing that beats subscribing to *CQ* and *CQ VHF* magazines for the latest on what's happening in the hobby. There is the also CQ Store (<http://store.cq-amateur-radio.com/StoreFront.bok>), a place to wander via your internet connection (www.cq-amateur-radio.com) and procure technical literature that is second to none.

I had brought several issues of *CQ*, *CQ VHF*, and *Popular Communications* (the latter a CQ Communications magazine basically dedicated to shortwave radio and related hobbies) with me to our meeting and presented them to Jay, telling him that the authors published in these magazines were experienced radio enthusiasts and their columns, along with the feature articles, were a great place to obtain pertinent information about the radio hobby.

One other thought I imparted to Jay was that all of the authors, myself included, need feedback from the readership. We need this information because it tells us whether or not we are hitting our target audience and how well we are doing. Positive or negative, all writers need this information to tweak their material to include the things that people need and want to know.

I gave Jay my e-mail address and told him to look over my "Learning Curve" column in *CQ* and my "Beginner's Guide" column in *CQ VHF* and to please provide me with some real-time feedback on what he thought and what he'd like to see included in the columns.

As Jay and I parted, I had the distinct feeling that this young man would go far, both in the ham radio hobby and his professional career. As a parting gesture I asked Jay to relay to his parents my personal thanks for his father's service to our country. It's people like Jay's dad who allow all of us to pursue a ham radio hobby in a free country. Also, now that his mom knows as much about ham radio as Jay does, when will she get her license? Jay grinned and with a shrug said, "I've been trying to convince her to take the Technician test, honest!"

Riding the emotional high of my meeting with Jay, I returned to the CQ booth at Dayton. If being a columnist has a downside, it is not being able to address everyone's needs. However, the editorial talent available from the authors who contribute to the magazines and books published by CQ Communications is second to none. We can, and should, use that talent to continue and promote the wonderful hobby of ham radio.

Speaking of Feedback . . .

The complex answer to the question of republishing articles and columns is directly related to copyright restrictions. Thankfully, with CQ Communications the authors are able to retain their rights and can republish as they see fit after the article or column has been printed and received by the subscribers, with certain caveats explained below. This is great news, as it allows me the opportunity to target an audience that may have missed the original material.

In addition to the contents of the columns, I am planning on adding instructional videos on how to solder, installing coaxial connectors, how to properly and safely erect antennas, and a host of other topics. Remember, this will be about 12 months from now, so don't expect to see this very soon. The ham radio hobby is too important *not* to proceed with an additional internet medium such as this. Besides, CD/DVDs are a great way to catalog and collect a huge amount of data in a manageable format. I propose to offer a collection of the "Learning Curve" columns along with other information on a CD/DVD in about a year.

The complex answer to the question of publishing articles and columns by each specific author is directly related to copyright restrictions. Regarding CQ Communications, the authors are able to retain the rights to their material once it has been

published in each of the magazines, and can make it available to the public, while CQ Communications retains rights of the presented layout in each magazine, which is not able to be reproduced without expressed written permission and credit from the publisher. This is great news, as it allows me, along with my fellow authors, the chance to target an audience that may have missed the original material.

In addition to the contents of my columns, I am planning material related to properly and safely erect antennas, and a host of other topics. Remember, this will be about 12 months from now, so don't go out expecting to see this very soon.

Further Information

Another question that often arises: "What are the necessary books I need to add to my technical library?" Believe it or not, that is a pretty easy one to answer.

When I first started college, my professor's book list included, among other titles, the current edition of the ARRL's *Handbook*, along with the current edition of Robert L. Shrader's *Electronic Communications*. If you look closely at past issues of *CQ* you will find Robert Shrader's by-line on a number of articles. Bob Shrader is no stranger to the radio hobby press. (Note: I have found the 6th edition of *Electronic Communications on Amazon.com*. This apparently is the last or current edition of this fine text.)

In addition to these two books, a number of selections from CQ's Bookstore (especially *The NEW Shortwave Propagation Handbook*, the book by Lew McCoy on antennas, plus more of CQ's own books and a good cross-section of RSGB [Radio Society of Great Britain] pubs, adding many books on other topics of interest) are available. Also keep a lookout for new titles from CQ coming soon, stopping by the CQ booth at the Hamvention® or checking current magazines for a listing.

The information is definitely out there. It's just a matter of prioritizing your needs and buying books and digital media as needed.

That's a wrap for this time. Don't forget to get on the air, as the 6-meter band is opening on a regular basis, and let's not forget the multitude of contests geared to the VHF+ crowd. See you on the bands!

73, Rich, K7SZ

FM

FM/Repeaters—Inside Amateur Radio's "Utility" Mode

What is a Trail Friendly Radio?

This column is adapted from an article originally published in the Summer 2009 issue of QRP Quarterly, the official publication of the QRP Amateur Club International. It strays a bit from the pure FM/repeater focus of this column, but I hope you find it interesting. —KØNR

In the QRP world, there is a notion of a Trail Friendly Radio (TFR), which usually refers to QRP rigs for the HF bands. The basic definition of a TFR usually includes light weight and portability, low power (battery drain), and ease of operation in typical "on the trail" situations. On the trail might also mean sitting on the beach, paddling a canoe, or maybe sitting on the back deck at home, but you get the idea. Some hams have emphasized the need for "controls on the top of the radio," but I'll just refer to this as appropriate design for trail-operating conditions. A good example of a TFR is the Elecraft KX-1.

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This got me thinking about the question of what constitutes a TFR for the VHF and higher bands? Does one exist today? I did a little poking around on the internet to see if this issue has been discussed much. Not finding anything, I posed the question on the vhfqrp Yahoo group and my twitter feed, and received some good comments.

TRF for VHF

Rather than dive into the specific features of a VHF TRF (shortened to VTRF), let's first look at how we would apply it. I imagine using a VTRF for a walk around the park, a day hike in the forest, or an overnight backpacking trip. Obviously, I'd want the VTRF to be independent of AC power, compact, and easy to carry. I'd want to be able to work all modes on 50 MHz, 144 MHz, and 432 MHz, the most popular VHF (and one UHF) bands. CW and SSB are important for serious weak-signal work on all three bands and sporadic-E openings on 6 meters. There is nothing more fun than catching a good 6-meter opening during the summer months out "on the trail."



Photo 2. The Yaesu VX-3R is an example of a "mini-HT" with dualband (2 meters and 70 cm) capability.



Photo 1. The Yaesu FT-817ND covers the HF, 6-meter, 2-meter, and 70-cm bands in one rig.

Although less efficient, having FM provides access to the largest number of VHF radio operators, and, yes, of course, I would want to be able to work those FM repeaters when wandering in the back country (or lying on the beach). Adding to the wish list, I'll include some of the fancy extras common to typical handheld FM transceivers: weather radio receive, FM broadcast receive, extended coverage receive for fire/police/forest service, etc. These features let me keep tabs on the weather and listen in on public service agencies such as park rangers and fire departments.



Photo 3. The KK7B RCX2 receive converter for 2 meters.

I had several people mention to me that APRS is a great capability to have on the trail. People commented that they can hitch an HT (such as the Kenwood TH-D7AG) to a small GPS receiver to create a compact position reporting station. Family members back home can keep tabs on your location via the various APRS websites. Yaesu offers a GPS option for the VX-8R handheld radio and is just now introducing the VX-8GR with GPS built in. I tend to carry a GPS with me when doing VTRF activity anyway, so coupling it to the VTRF makes sense to me.

This is a tough set of requirements, but what the heck. It never hurts to dream big!

Practical Choices

Let's bring this down to reality by looking at some practical choices for a VTRF. The first radio that comes to mind is the Yaesu FT-817 (photo 1), since it is the only commercially available rig that is relatively compact, portable, and has CW/SSB/FM on the three bands of interest. It has the added benefit of covering the HF bands as well. Unfortunately, the FT-817 does have a significant flaw: it is a battery hog. The FT-817ND manual lists the receive (standby) current as 250 mA (squelled) and 450 mA (un-squelled). Compare this to, say, an Elecraft KX-1 with a receive current of 34 mA (typical). This is a real problem for extended portable operation. A less significant shortcoming of the FT-817 is that the extended receive frequency coverage on the 2-meter band stops at 154

MHz, missing the U.S. weather radio band at 162 MHz. For trail-friendly operating, it is really handy to be able to check the weather forecast.

Next on our list of potential VTFRs is the good old FM handheld transceiver (see "My QRP Rig is an HT," *QRP Quarterly*, Summer 2008). Of course, the HT falls short on the ability to do CW and SSB. It does excel in the compact and portable category, as it is hard to beat how an HT slips onto your belt or into a pocket. Dualband HTs are very affordable, usually covering the 2-meter and 70-cm bands. Some of them include 6 meters but only on FM.

There is a class of mini-HTs that includes the Yaesu VX-3R and the ICOM IC-P7A, which are extremely compact and easy to carry (photo 2). Both of these radios have a rich feature set and extended coverage receive (from the AM broadcast band all the way up through UHF). While they are compact in size, they still pack in the features. These small radios are a shirt-pocket ham shack. They are a bit light on output power, producing only 1.5 watts when using the standard battery pack.

As mentioned previously, having an APRS transmitter in your equipment is a handy way to bleep out position information and other messages. The classic handheld radio for APRS is the Kenwood TH-D7AG (now discontinued), but now Yaesu has joined the party with the VX-8 series. These rigs are full-featured, with a hefty 5 watts of RF output power.

QRPers like to build kits, even for the



Photo 4. Some telescoping BNC antennas.

VHF bands. Rick, KK7B, recently introduced some VHF kits that are of interest to us. The RCX2 is a receive converter for the 2-meter band that translates down to 7 MHz, for use with your favorite 40-meter QRP transceiver, including the KK7B microR2 (photo 3). The RCX1-6 converter is the same basic kit but receives the 6-meter band. For transmit, KK7B also has kits for two CW sources for 2 meters and 6 meters, with an output power of 10 mW. The KK7B kits fall short of my ideal VTFR, but are a fun way to get on the air with a rig that you can build.

Antennas

Every radio needs an antenna, so what kind of antennas will we use for our VTFR? All handheld transceivers come equipped with shortened vertical antennas known as "rubber ducks." The FT-817 also comes standard with a large rubber-duck antenna that works better than you might expect. Still, however, these antennas are limited in size and gain, so there are a number of longer telescoping BNC antennas available (photo 4). These antennas will work well when moving on the trail and temporarily setting up.

We might want something more capable if we stop for the night. For 6 meters,



Photo 5. The Arrow II antenna is a Yagi that works on 2 meters and 70 cm.

operating, I will take along a radio that can do SSB and CW. Basically, the only practical choice is the FT-817 . . . with a big battery. I use it often in VHF contests and other operating events.

What's your VTFR? Drop me a note at <bob@k0nr.com> or stop by the blog at <www.k0nr.com/blog>. 73, Bob, KØNR

References

Elecraft website: <http://www.elecraft.com/>
 VHF QRP Yahoo Group: <http://groups.yahoo.com/group/vhfqrp/>
 KK7B Kits, Kanga US: <http://www.kangaus.com/>
 KI6SN's monthly TFR column in *Worldradio Online*

we can use the standard dipole, cut to resonate on 50 MHz. For the 2-meter and 70-cm bands, a small Yagi might be the way to go (photo 5). Experimenting with antennas is always a fun part of the hobby, so it is great to try out different antennas that work well for your specific operating conditions.

more expensive than a single-band radio. Some folks will want 222 MHz and maybe 50 MHz as well, depending on the available repeaters. Let's face it: Most of the VHF and higher activity is on FM, so carrying an HT is a very practical choice. Also, you cannot beat the compact size of these radios.

If I am really thinking serious VHF +

Sum It Up

By my definition, there really isn't an excellent VTRF available today. The FT-817 comes quite close, except for the battery-drain issue. Maybe we just have to overlook that. (Several people suggested that we should *just get over it* and accept having to carry a larger battery.) I don't suppose that Yaesu is too worried about the battery issue, since the FT-817 is unmatched in the marketplace. I wonder if one of the manufacturers might start sneaking in some basic CW and SSB capability into their handheld radios? It is technically feasible, but the market demand may not drive them to do it. Mizuho (and others) used to have SSB handhelds for both HF and VHF bands, but they are no longer made.

Faced with such a dilemma, what do I really do? My first choice for casual hiking, day trips, and backpacking is still the common FM handheld transceiver. There are many to choose from, available from ICOM, Yaesu, Kenwood, and Alinco (photos 6 and 7). I lean heavily towards the 2-meter and 70-cm dual-band rigs, since they are not that much



Photo 6. The VX-8R is a classic HT design with optional GPS receiver.

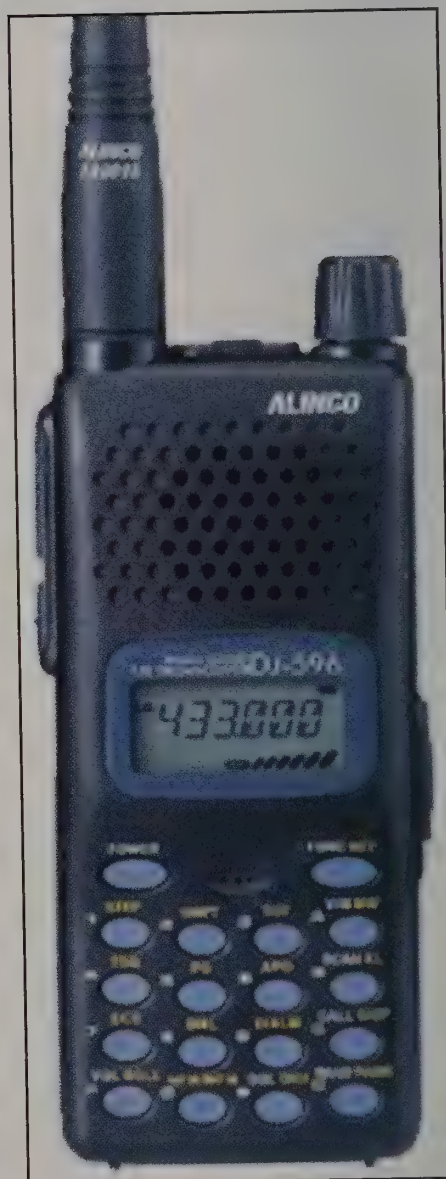


Photo 7. The Alinco DJ-596T is a classic dualband handheld radio.

CQ's 6 Meter and Satellite WAZ Awards

(As of April 1, 2010)

By Floyd Gerald,* N5FG, CQ WAZ Award Manager

6 Meter Worked All Zones

No.	Callsign	Zones needed to have all 40 confirmed			
1	N4CH	16,17,18,19,20,21,22,23,24,25,26,28,29,34,39	49	TISKD	2,17,18,19,21,22,23,26,27,34,35,37,38,39
2	N4MM	17,18,19,21,22,23,24,26,28,29,34	50	W9RPM	2,17,18,19,21,22,23,24,26,29,34,37
3	J1ICQA	2,18,34,40	51	N8KOL	17,18,19,21,22,23,24,26,28,29,30,34,35,39
4	K5UR	2,16,17,18,19,21,22,23,24,26,27,28,29,34,39	52	K2YOF	17,18,19,21,22,23,24,25,26,28,29,30,32,34
5	EH7KW	1,2,6,18,19,23	53	WA1ECF	17,18,19,21,23,24,25,26,27,28,29,30,34,36
6	K6EID	17,18,19,21,22,23,24,26,28,29,34,39	54	W4TJ	17,18,19,21,22,23,24,25,26,27,28,29,34,39
7	K0FF	16,17,18,19,20,21,22,23,24,26,27,28,29,34	55	JM1SZY	2,18,34,40
8	JF1IRW	2,40	56	SM6FHZ	1,2,3,6,12,18,19,23,31,32
9	K2ZD	2,16,17,18,19,21,22,23,24,26,28,29,34	57	N6KK	15,16,17,18,19,20,21,22,23,24,34,35,37,38,40
10	W4VHF	16,17,18,19,21,22,23,24,25,26,28,29,34,39	58	NH7RO	1,2,17,18,19,21,22,23,28,34,35,37,38,39,40
11	G0LCS	1,6,7,12,18,19,22,23,28,31	59	OK1MP	1,2,3,10,13,18,19,23,28,32
12	JR2AUE	2,18,34,40	60	W9JUV	2,17,18,19,21,22,23,24,26,28,29,30,34
13	K2MUB	16,17,18,19,21,22,23,24,26,28,29,34	61	K9AB	2,16,17,18,19,21,22,23,24,26,28,29,30,34
14	AE4RO	16,17,18,19,21,22,23,24,26,28,29,34,37	62	W2MPK	2,12,17,18,19,21,22,23,24,26,28,29,30,34,36
15	DL3DXX	18,19,23,31,32	63	K3XA	17,18,19,21,22,23,24,25,26,27,28,29,30,34,36
16	W5OZI	2,16,17,18,19,20,21,22,23,24,26,28,34,39,40	64	KB4CRT	2,17,18,19,21,22,23,24,26,28,29,34,36,37,39
17	WA6PEV	3,4,16,17,18,19,20,21,22,23,24,26,29,34,39	65	JH7IFR	2,5,9,10,18,23,34,36,38,40
18	9A8A	1,2,3,6,7,10,12,18,19,23,31	66	K0SQ	16,17,18,19,20,21,22,23,24,26,28,29,34
19	9A3JJ	1,2,3,4,6,7,10,12,18,19,23,26,29,31,32	67	W3TC	17,18,19,21,22,23,24,26,28,29,30,34
20	SP5EWY	1,2,3,4,6,9,10,12,18,19,23,26,31,32	68	IK0PEA	1,2,3,6,7,10,18,19,22,23,26,28,29,31,32
21	W8PAT	16,17,18,19,20,21,22,23,24,26,28,29,30,34,39	69	W4UDH	16,17,18,19,21,22,23,24,26,27,28,29,30,34,39
22	K4CKS	16,17,18,19,21,22,23,24,26,28,29,34,36,39	70	VR2XMT	2,5,6,9,18,23,40
23	HB9RUZ	1,2,3,6,7,9,10,18,19,23,31,32	71	EH9IB	1,2,3,6,10,17,18,19,23,27,28
24	JA3IW	2,5,18,34,40	72	K4MQG	17,18,19,21,22,23,24,25,26,28,29,30,34,39
25	IK1GPG	1,2,3,6,10,12,18,19,23,32	73	JF6EZY	2,4,5,6,9,19,34,35,36,40
26	W1AIM	16,17,18,19,20,21,22,23,24,26,28,29,30,34	74	VE1YX	17,18,19,23,24,26,28,29,30,34
27	K1LPS	16,17,18,19,21,22,23,24,26,27,28,29,30,34,37	75	OK1VBN	1,2,3,6,7,10,12,18,19,22,23,24,32,34
28	W3NZL	17,18,19,21,22,23,24,26,27,28,29,34	76	UT7QF	1,2,3,6,10,12,13,19,24,26,30,31
29	K1AE	2,16,17,18,19,21,22,23,24,25,26,28,29,30,34,36	77	K5NA	16,17,18,19,21,22,23,24,26,28,29,33,37,39
30	IW9CER	1,2,6,18,19,23,26,29,32	78	I4EAT	1,2,6,10,18,19,23,32
31	IT9IPQ	1,2,3,6,18,19,23,26,29,32	79	W3BTX	17,18,19,22,23,26,34,37,38
32	G4BWP	1,2,3,6,12,18,19,22,23,24,30,31,32	80	JH1HHC	2,5,7,9,18,34,35,37,40
33	LZ2CC	1	81	PY2RO	1,2,17,18,40M,19,21,22,23,26,28,29,30,38,39,40
34	K6MIO/KH6	16,17,18,19,23,26,34,35,37,40	82	W4UM	18,19,21,22,23,24,26,27,28,29,34,37,39
35	K3KYR	17,18,19,21,22,23,24,25,26,28,29,30,34	83	ISKG	1,2,3,6,10,18,19,23,27,29,32
36	YV1DIG	1,2,17,18,19,21,23,24,26,27,29,34,40	84	DF3CB	1,2,12,18,19,32
37	K0AZ	16,17,18,19,21,22,23,24,26,28,29,34,39	85	K4PI	17,18,19,21,22,23,24,26,28,29,30,34,37,38,39
38	WB8XX	17,18,19,21,22,23,24,26,28,29,34,37,39	86	WB8TGY	16,17,18,19,21,22,23,24,26,28,29,30,34,36,39
39	K1MS	2,17,18,19,21,22,23,24,25,26,28,29,30,34	87	MU0FAL	1,2,12,18,19,22,23,24,26,27,28,29,30,31,32
40	ES2RJ	1,2,3,10,12,13,19,23,32,39	88	PY2BW	1,2,17,18,19,22,23,26,28,29,30,38,39,40
41	NW5E	17,18,19,21,22,23,24,26,27,28,29,30,34,37,39	89	K4OM	17,18,19,21,22,23,24,26,28,29,32,34,36,38,39
42	ON4AOI	1,18,19,23,32	90	JH0BBE	2,33,34,40
43	N3DB	17,18,19,21,22,23,24,25,26,27,28,29,30,34,36	91	K6QXY	17,18,19,21,22,23,34,37,39
44	K4ZOO	2,16,17,18,19,21,22,23,24,25,26,27,28,29,34	92	JA8ISU	2,7,8,9,19,33,34,36,37,38,39,40
45	G3VOF	1,3,12,18,19,23,28,29,31,32	93	YO9HP	1,2,6,7,11,12,13,18,19,23,28,29,30,31,40
46	ES2WX	1,2,3,10,12,13,19,31,32,39	94	SV8CS	1,2,6,7,18,19,23,26,28,29
47	IW2CAM	1,2,3,6,9,10,12,18,19,22,23,27,28,29,32	95	SM3NRY	1,6,10,12,13,19,23,25,26,29,30,31,32,39
48	OE4WHG	1,2,3,6,7,10,12,13,18,19,23,28,32,40	96	VK3OT	2,10,11,12,16,34,35,37,39,40

Satellite Worked All Zones

No.	Callsign	Issue date	Zones Needed to have all 40 confirmed
1	KL7GRF	8 Mar. 93	None
2	VE6LQ	31 Mar. 93	None
3	KD6PY	1 June 93	None
4	OH5LK	23 June 93	None
5	AA6PJ	21 July 93	None
6	K7HDK	9 Sept. 93	None
7	W1NU	13 Oct. 93	None
8	DC8TS	29 Oct. 93	None
9	DG2SBW	12 Jan. 94	None
10	N4SU	20 Jan. 94	None
11	PA0AND	17 Feb. 94	None
12	VE3NPC	16 Mar. 94	None
13	WB4MLE	31 Mar. 94	None
14	OE3JIS	28 Feb. 95	None
15	JA1BLC	10 Apr. 97	None
16	F5ETM	30 Oct. 97	None
17	KE4SCY	15 Apr. 01	10,18,19,22,23,24,26,27,28,29,34,35,37,39
18	N6KK	15 Dec. 02	None
19	DL2AYK	7 May 03	2,10,19,29,34
20	N1HOQ	31 Jan. 04	10,13,18,19,23,24,26,27,28,29,33,34,36,37,39
21	AA6NP	12 Feb. 04	None
22	9V1XE	14 Aug. 04	2,5,7,8,9,10,12,13,23,34,35,36,37,40
23	VR2XMT	01 May 06	2,5,8,9,10,11,12,13,23,34,40
24	XE1MEX	19 Mar. 09	2,17,18,21,22,23,26,34,37,40

CQ offers the Satellite Work All Zones award for stations who confirm a minimum of 25 zones worked via amateur radio satellite. In 2001 we "lowered the bar" from the original 40 zone requirement to encourage participation in this very difficult award. A Satellite WAZ certificate will indicate the number of zones that are confirmed when the applicant first applies for the award.

Endorsement stickers are not offered for this award. However, an embossed, gold seal will be issued to you when you finally confirm that last zone.

Rules and applications for the WAZ program may be obtained by sending a large SAE with two units of postage or an address label and \$1.00 to the WAZ Award Manager: Floyd Gerald, N5FG, 17 Green Hollow Rd., Wiggins, MS 39577. The processing fee for all CQ awards is \$6.00 for subscribers (please include your most recent CQ or CQ VHF mailing label or a copy) and \$12.00 for nonsubscribers. Please make all checks payable to Floyd Gerald. Applicants sending QSL cards to a CQ Checkpoint or the Award Manager must include return postage. N5FG may also be reached via e-mail: <n5fg@cq-amateur-radio.com>.

*17 Green Hollow Rd., Wiggins, MS 39577; e-mail: <n5fg@cq-amateur-radio.com>

VHF PROPAGATION

The Science of Predicting VHF-and-Above Radio Conditions

Aurora Season and the New Solar Cycle

Since the last edition of this column, the new sunspot Cycle 24 has become reliably active. From the beginning of 2010, until press time, we have witnessed a nearly consistent parade of new sunspots. With this exciting sunspot activity comes some of the most intense solar flares and geomagnetic storms so far in the new cycle. For several years we've seen long periods when there were no sunspots on the sun. Since January 1, 2010, there have been very few periods with zero sunspots, and each has been very short.

The period from mid-January through April up to press time has revealed a constant appearance of active sunspot regions. By January 19, the sun became very active and produced a constant stream of x-ray flares, some of them moderately powerful (figure 1). Conditions continued to improve, and February became the month of incredible excitement. By February 7, the official Pentiction, BC, Canada 10.7-cm radio flux was 90. By February 12, solar activity ranged from low to high, and included the largest M-class flare yet recorded in solar Cycle 24. This flare originated in Active Region 1046, and was the source of a full-halo coronal mass ejection (CME) that was aimed directly toward Earth. This later produced minor aurora and geomagnetic disturbances. Active Region 1045 also produced a series of flares, including another M-class X-ray flare. By February 12, the 10.7-cm flux peaked at 96, just shy of 100! This level of activity was last seen in 2006.

All of this solar activity creates opportunity for possible VHF activity because of the increased chance of CMEs and increased solar winds. As sunspot regions grow larger and the number of spots increases, the sun also unleashes many flares. Often, when a flare explodes, it can unleash an associated CME toward Earth. This massively huge cloud of solar plasma (billions of tons!) arrives about three days later, and could cause geomagnetic disturbances, sometimes even causing "storm-level" geomagnetic activity. These geo-

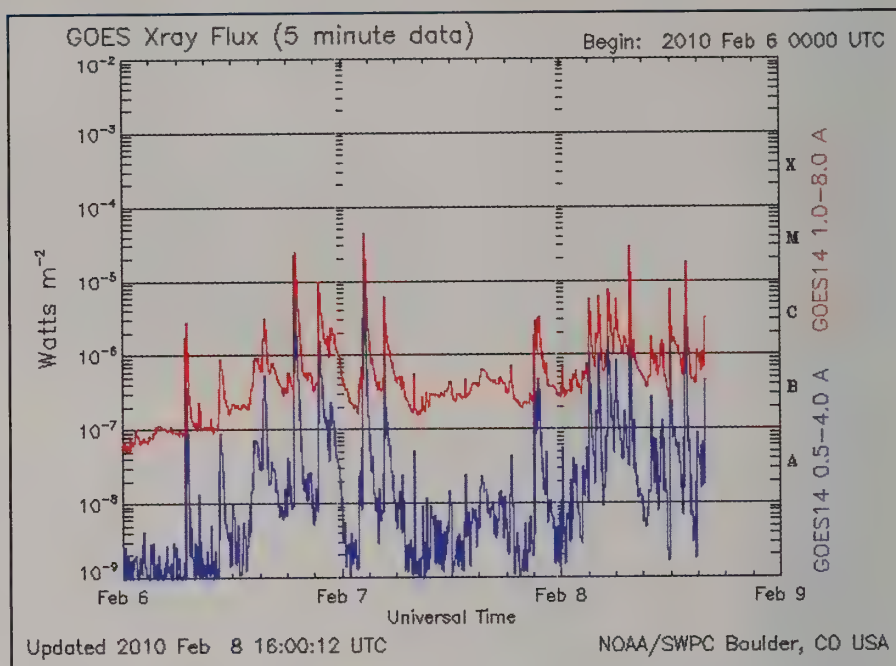


Figure 1. Sunspot Cycle 24 has consistently produced new sunspots since the end of 2009. During February 2010, the most powerful X-ray flares to date in the new cycle erupted one after another. This X-ray graph shows the steady "stream" of X-ray flares erupting from February 6 through February 9, 2010. (Source: Space Weather Prediction Center [SWPC]/The National Oceanic and Atmospheric Administration [NOAA])

magnetic disturbances counter any positive effect that the increased sunspot activity may have on radio signal propagation on the frequencies below 6 meters.

To the joy of VHF weak-signal enthusiasts, however, these geomagnetic storms often enable propagation of signals via "aurora-mode propagation." Auroral activity occurs at the E-region of the ionosphere, and "clouds" of highly ionized clouds form which in turn may reflect radio signals in VHF and sometimes even UHF spectrum.

Auroral observations over the last 100 years reveal that peak periods of radio aurora occur close to the equinoxes—that is, during the months of March and April, and again in September and October. Of the two yearly peaks, the greater peak, in terms of the number of contacts reported, occurs during October. However, some of the strongest levels of geomagnetic storms are in the spring. The minimum activity yearly occurs during the months

of June and July, with a lesser minimum during December.

Aurora is a direct result of solar plasma interacting with gasses in the upper atmosphere. Geomagnetic storms develop when strong gusts of solar wind and CMEs (see figure 2) hit the Earth's magnetosphere in just the right way. The magnetosphere (figure 3) is filled with electrons and protons that are normally trapped by lines of magnetic force that prevent them from escaping to space or descending to the planet below.

When the impact of a CME breaks loose some of those trapped particles, it causes them to rain down on the atmosphere. Gases in the atmosphere start to glow under the impact of these particles. Different gases give out various colors. Think of a neon sign and how the plasma inside the glass tube, when excited, glows with a bright color. When the molecules and atoms are struck by solar wind particles, the stripping of one or more of their elec-

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trons ionizes them to such an extent that the ionized area is capable of reflecting radio signals at very high frequencies. This ionization occurs at an altitude of about 70 miles, very near the *E*-layer of the ionosphere. The level of ionization depends on the energy and amount of solar wind particles able to enter the atmosphere.

These precipitating particles mostly follow the magnetic field lines that run from Earth's magnetic poles, and are concentrated in circular regions around the magnetic poles called "auroral ovals." These bands expand away from the poles during magnetic storms. The stronger the storm, the greater these ovals will expand. Sometimes they grow so large that people at middle latitudes, such as in California, can see these "Northern Lights."

While correlations exist between visible and radio aurora, radio aurora could exist without visual aurora. Statistically, a diurnal variation of the frequency of radio aurora contacts has been identified that suggests two strong peaks, one near 6 PM and the second around midnight, local time.

VHF auroral echoes, or reflections, are most effective when the angle of incidence of the signal from the transmitter, with the geomagnetic field line, equals the angle of reflection from the field line to the receiver. Radio aurora is observed almost exclusively in a sector centered on magnetic north. The strength of signals reflected from the aurora is dependent on the wavelength when equivalent power levels are employed. Six-meter reflections can be expected to be much stronger than 2-meter reflections for the same transmitter output power. The polarization of the reflected signals is nearly the same as that of the transmitted signal.

The planetary *K*-index (*Kp*) is a good indicator of the expansion of the auroral oval, and the possible intensity of the aurora. When the *K*-index is higher than 5, most operators in the northern states and in Canada can expect favorable aurora conditions. If the *K*-index reaches 8 or 9, it is highly possible for radio aurora to be observed by stations as far south as California and Florida.

Look for aurora-mode propagation when the *Kp* rises above 4, and look for visual aurora after dark when the *Kp* rises above 5. The higher the *Kp*, the more likely you may see the visual lights. However, you don't have to see them to hear their influence on propagation. Listen for stations from over the poles that sound raspy or fluttery on frequen-



Figure 2. The Heliospheric Imager (HI) on the STEREO Ahead spacecraft observed as solar wind streamed from the sun and three coronal mass ejections (CMEs), which appear as more distinct, elongated clouds, expanded into space over a 15-day period (March 11–25, 2010). The HI instruments on each of the two STEREO spacecraft are off-pointed from the sun to observe a 20-degree field of view to the left and the right of the sun, beginning four degrees from the sun's center. Its sensitive instruments are attuned to observing the faint structures and particle streams billowing out from the sun. With the two perspectives, scientists are gaining a better understanding of how solar wind and CME structures evolve as they head into space. Solar wind constantly streams away from the sun, while CMEs are less frequent but much more powerful clouds of particles caused by solar explosions. (Source: SOHO [Solar and Heliospheric Observatory])

cies above 28 MHz, possibly up as high as 440 MHz. Sometimes aurora will enhance a path at certain frequencies, while at other times it will degrade the signals. Sometimes signals will fade quickly and then come back with great strength. The reason for this is that the radio signal is being refracted off the more highly ionized areas that are lit up. These ionized areas ebb and flow, so the ability to refract changes, sometimes quickly. I've observed the effect of aurora and associated geomagnetic storminess even on lower HF frequencies.

During February, the arrival of flare-triggered CMEs produced active geomagnetic disturbances and minor aurora. March was quieter than February, but

April, on the other hand, was a very exciting month. On April 5, a strong solar wind shockwave crashed into the Earth's magnetosphere, causing a major geomagnetic storm (figure 4). This was the result of a CME unleashed from the sun only three days prior. The timing was right for such a shockwave to trigger aurora. The initial shockwave pushed the *K*-index up to 7, and the storm continued for the next couple of days, slowly weakening. This storm and related aurora were the strongest yet of sunspot Cycle 24.

More on the *K*-index

The *K*-index is a code that is related to the maximum fluctuations of horizontal

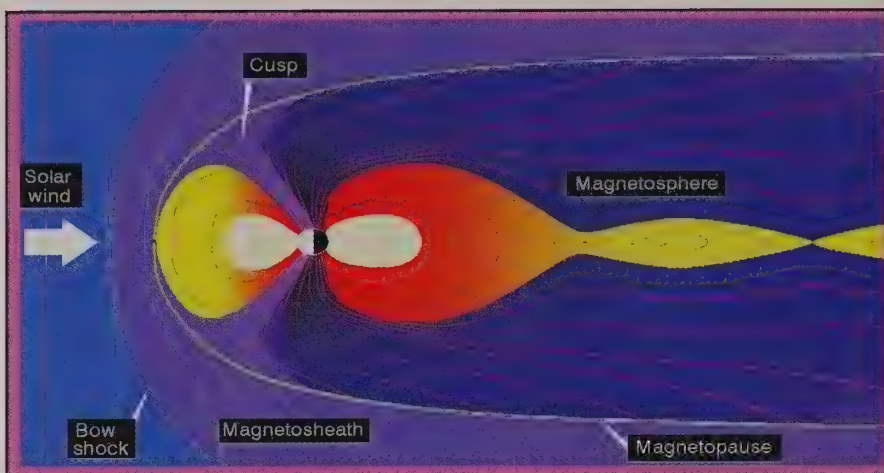


Figure 3. The Earth's magnetic field is completely invisible, but it can be felt by a compass needle on the Earth's surface, and it reaches thousands of miles out into space. The magnetosphere of Earth is a region in space whose shape is determined by the Earth's internal magnetic field, the solar wind plasma, and the interplanetary magnetic field (IMF). In the magnetosphere, a mix of free ions and electrons from both the solar wind and the Earth's ionosphere is confined by electromagnetic forces that are much stronger than gravity and collisions. Despite its name, the magnetosphere is distinctly non-spherical. Earth's magnetic field gets stretched out into a comet-like shape with a tail of magnetism that stretches millions of miles behind Earth, opposite from the sun. The sun has a wind of gas that pushes Earth's field from the left to the right, in this drawing. (Source: NASA)

components observed on a magnetometer relative to a quiet day, during a three-hour interval. The conversion table from maximum fluctuation (nT, "nano-Teslas") to *K*-index varies from observatory to observatory in such a way that the historical rate of occurrence of certain levels of *K* are about the same at all observatories. In practice, this means that observatories at higher geomagnetic latitude require higher levels of fluctuation for a given *K*-index. The conversion table for the Boulder magnetometer is shown below:

<i>K</i>	nT
0	0–5
1	5–10
2	10–20
3	20–40
4	40–70
5	70–120
6	120–200
7	200–330
8	330–500
9	>500

The final real-time *K*-index is determined after the end of prescribed three hourly intervals (0000–0300, 0300–0600 ... 2100–2400)

The official planetary *K*-index (*K_p*) is derived by calculating a weighted average of *K*-indices from a network of geo-

magnetic observatories. Since these observatories do not report their data in real time, it is necessary for an operations center such as ourselves to make the best estimate we can of this index based on available data. Space weather operations uses near real-time estimates of the *K_p* index which are derived by the U.S. Air Force 55th Space Weather Squadron. These estimates of *K_p* are based on a network of observatories reporting in near real time. Most of the observatories are in North America, although there is one European station also contributing at this time (Hartland, UK).

The *K_p* scale is a reasonable way to summarize the global level of geomagnetic activity, but it has not always been easy for those affected by the space environment to understand its significance. The NOAA G-scale was designed to correspond, in a straightforward way, to the significance of effects of geomagnetic storms. To rate the geomagnetic activity using the G-scale, estimates of the planetary average *K_p* index are used to determine geomagnetic storm (NOAA Space Weather Scale) levels, as shown below:

<i>K_p</i> -index	Geomagnetic Storm Level
<i>K_p</i> = 5	G1
<i>K_p</i> = 6	G2
<i>K_p</i> = 7	G3

<i>K_p</i> = 8	G4
<i>K_p</i> = 9	G5

K_p of 0 to 4 is below storm, which has the label of G0.

The geomagnetic storm of April 5 was a G3-level event.

Spring 2010 VHF Propagation

As we move into May, short-distance (only short when compared to long-haul DX of thousands of miles often experienced in the high-frequency spectrum) hundreds of miles) propagation opens up in the VHF and sometimes UHF spectrums. These opening provide propagation of radio signals for hundreds of miles, and occur almost as if a switch is turned on. This is a mostly summer-time phenomenon called sporadic-E.

Sporadic-E (*Es*) is the term given to the mode of propagation in which clouds of highly dense ionization develop in the E-layer of the ionosphere. These clouds might be very small, but regardless of their size, they seem to drift and move about, making the propagation off these clouds short and unpredictable. It is well documented that *Es* occurs most often in the summer, with a secondary peak in the winter. These peaks are centered very close to the solstices. The winter peak can be characterized as being five to eight times less than the summer *Es* peak.

Ten-meter operators have known *Es* propagation as the summertime "short skip." These "clouds" appear unpredictably, but they are most common over North America during the daylight hours of late spring and summer. *Es* events may last for just a few minutes to several hours and usually provide an opening to a very small area of the country at any one time.

During periods of intense and widespread *Es* ionization, two-hop openings considerably beyond 1400 miles should be possible on 6 meters. Short-skip openings between about 1200 and 1400 miles may also be possible on 2 meters.

For a great introduction on mid-latitude sporadic-E propagation, visit the AM-FM DX Resource website <<http://www.amfmdx.net/propagation/Es.html>>.

Tropospheric Ducting

Most propagation on VHF and above occurs in the troposphere. There are a number of well-documented modes of tropospheric propagation. The most common is line-of-sight propagation, which

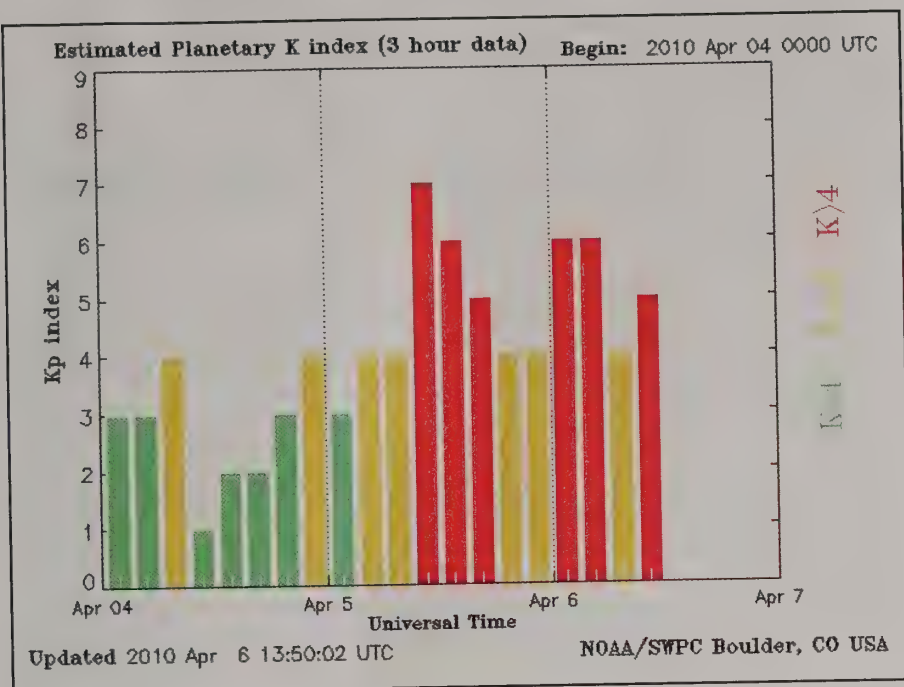


Figure 4. An interplanetary shock was detected around 0800 UTC April 5 on the ACE spacecraft. It was probably linked to a halo CME, which occurred on April 3, 2010. A G3-level geomagnetic storm (see text) occurred when the shockwave, riding the high-speed solar wind, crashed into the Earth's magnetosphere. Major storm conditions were observed in Boulder, Wingst, and Niemegk observatories. The planetary K-index reached a level of 7 on April 5, as seen in this plot. (Source: Space Weather Prediction Center/NOAA)

can, depending on the height of the transmitting and the receiving antennas, extend to about 25 miles. When you work simplex FM or FM repeaters in your local area, you are hearing typical line-of-sight tropospheric propagation.

Another possible mode of propagation is by tropospheric ducting. The term "tropospheric ducting" refers to the stratification of the air within the troposphere. These ducts are created by inversion layers formed from solar warming of the ground and the atmosphere immediately above it.

Under perfect conditions, the troposphere is characterized by a steady decrease in both temperature and pressure as height increases. When layers form within this region of air, the refractive index between each layer causes a refraction of VHF and UHF radio waves. If the layers form in just the right way and at the right height, a natural wave-guide is created. A tropospheric duct develops. A VHF signal can be ducted hundreds if not thousands of miles. It is common for California stations to work Hawaii stations during tropospheric ducting between the islands and the mainland.

It is worth watching for this mode of

propagation. The spring weather season may well be violent and eventful this year, as has already been the case. Advanced visual and infrared weather maps can be a real aid in detecting the undisturbed low clouds between the West Coast and Hawaii or farther during periods of intense subsidence-inversion band openings. This condition also occurs over the Atlantic. There is a great resource on the internet that provides a look into current conditions. Bill Hepburn has created forecast maps and presents them at <<http://www.dxinfocentre.com/tropo.html>>, which includes maps for the Pacific, Atlantic, and other regions.

If you know that conditions are favorable for tropospheric ducting in your area, try tuning around the 162-MHz weather channels to see if you can hear stations way beyond your normal line-of-sight reception. It is possible to hear stations over 800 miles away. Amateur radio repeaters are another source of DX that you might hear from the other end of the duct.

These openings can last for several days, and signals will remain stable and strong for long periods during the opening. The duct may, however, move slowly, causing you to hear one signal well for

a few hours, to then have it fade out and another station take its place from another area altogether.

The Solar Cycle Pulse

The observed sunspot numbers from January through February 2010 are 13.1 and 18.6. March numbers were not available at press-time. The smoothed sunspot counts for July and August 2009 are 3.6 and 4.8. The smoothed sunspot count for September 2009 was not available at press-time.

The monthly 10.7-cm (preliminary) numbers for January and February 2010 are 81.1, and 84.7. The smoothed 10.7-cm radio flux numbers for July and August 2009 are 71.0 and 72.1.

The smoothed planetary A-index (A_p) numbers for July and August 2009 are 3.9 and 3.8. The monthly readings for January and February 2010 are 3 and 4.

The smoothed monthly sunspot numbers forecast for May through July 2010 are 25.8, 28.8, and 31.7. The smoothed monthly 10.7-cm is predicted to be 85.1, 87.1, and 89.0 for the same months. Give or take about 12 points for all predictions. Clearly, the observed and calculated monthly numbers support the forecast of increasing sunspot activity. Sunspot Cycle 24 is alive and growing in strength.

(Note that these are preliminary figures. Solar scientists make minor adjustments after publishing by careful review).

Feedback, Comments, Observations Solicited!

I am looking forward to hearing from you about your observations of VHF and UHF propagation. Please send your reports to me via e-mail, or drop me a letter about your VHF/UHF experiences. I'll create summaries and share them with the readership. I look forward to hearing from you. Up-to-date propagation information is found at my propagation center at <<http://prop.hfradio.org/>>. If you are using Twitter, follow @hf radiospacewx for space weather and propagation alerts, and follow @NW7US to hear from me about various space weather and amateur radio news. Facebook members should check out the CQ VHF magazine Fan Page at <<http://tinyurl.com/cqvfffb>>, and the Space Weather and Radio Propagation Group at <<http://tinyurl.com/hfrswfb>>.

Until the next issue, happy weak-signal DXing.

73 de Tomas, NW7US

Petition to Establish a 4-meter Amateur Radio Band

By Glen E. Zook,* K9STH

Many newspapers around the U.S. print a page entitled "Op-Ed." This usually runs opposite the editorial page; hence its name. Sometimes the name takes on a double meaning, when the author has a viewpoint opposite to the editor's. Its purpose is to give a writer an opportunity to express a view or propose an idea for discussion in a longer format than what is normally found in a letter to the editor. There are many views and ideas floating around in the world of VHF that are worth considering and discussing. Please note that the views expressed herein are those of the author and do not reflect the views of CQ VHF or its editorial staff. —N6CL

On 27 January 2010, I submitted to the Office of the Secretary, Federal Communications Commission, a petition to establish a new, at least for amateur radio operators in the area governed by the FCC, amateur band in the 70.0-MHz to 70.5-MHz segment (see sidebar). There are reasons why this particular segment was chosen, including the fact that there are now 28 countries in Europe and Africa that have granted all, or part, of this segment to their amateur radio operators. Until the required transition to HDTV, the 66.0-MHz to 72.0-MHz range was utilized by television Channel 4. However, with the migration of commercial television broadcasting from Channel 4, this frequency range has become considerably less used. There are still a few television stations operating on Channel 4, but those are primarily "translator" stations used for getting television reception into mountain valleys and so forth. In addition, there are a "handful" of digital television stations now operating on the old Channel 4 frequencies. However, the areas in which there is still Channel 4 activity is minuscule when compared to the area of the entire country. Basically, I believe that there would

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Richardson, Texas 75080
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27 January 2010

Federal Communications Commission
Office of the Secretary
445 12th Street, SW
Washington, DC 20554

Subject: Petition for proposed changes in 47 CFR Part 97 Section 97.301(a) and Section 97.305(c) to add the 4-meter band

Commissioners:

The 4-meter (70.000 MHz to 70.500 MHz) amateur radio band has been authorized in a growing number of European and African nations and establishing such privileges for amateur radio operators in the United States and other areas over which the Commission has jurisdiction would be of great benefit to those operators residing in such areas. The recent migration of broadcast television stations to primarily the UHF frequencies basically eliminates any probable interference to television channels 4 or 5 which otherwise might have occurred because the 4-meter band is located on frequencies that were allocated to television channel 4. Since the 4-meter amateur radio band does not fall in the 72.0 MHz to 76.0 MHz segment which is allocated to Operational Fixed and various mobile services there would be no potential co-channel or adjacent channel interference.

It is proposed to allow all classes of amateur radio operators operating privileges on this new band. However, it is suggested that Novice Class licensees be restricted to a lower output level than those allowed for Technician Class, General Class, Advanced Class, and Amateur Extra Class licensees. If the present power output limitations of 1500 watts are granted to the higher class licensees then the Novice Class licensees should be restricted to no more than 200 watts power output as per most of the privileges granted those operators who hold a Novice Class license. If a lower power limit is placed on other classes of operator then the power output limits on the Novice Class should be reduced accordingly. For example, if power limitations of 200 watts maximum output power are placed on Technician Class and higher licensees, then it is suggested that Novice Class licensees be held to no more than 25 watts output.

One possible scenario would be to limit the Technician Class and higher licensees to 200 watts output power for a period of time (i.e. for 2 years) to determine any major interference problems which may occur by establishing these new operating privileges. At the end of that time, then the power output should be increased to the 1500 watts output power now allowed to Technician Class and higher class licensees. The power output allowed for Novice Class operations would then be 25 watts for 2 years increasing to 200 watts after the 2-year time frame.

It is recommended that 47 CFR Part 97 Section 97.301(a) have the following additions made:

Wavelength band	Region I	Region II	Region III	Sharing
4m	70.0–70.5 MHz	70.0–70.5 MHz	—	(a)
VHF				
4m	MCW, phone, image, RTTY, data, test			(2), (5), (8)

Respectively submitted:

Glen E. Zook, K9STH

and Section 97.305(c) have the following additions made:

be little, if any, possible interference from amateur radio operations in this frequency range.

There are those who believe that amateur radio should have a segment in the 72.0-MHz to 76.0-MHz range. However, that segment is now being used by all sorts of services, including the radio control of model cars, model boats, and model airplanes. Also, having an allocation in this range would not be compatible with the rest of the world. The end result is that I believe the best frequency segment is the 70.0-MHz to 70.5-MHz region.

The proposal would grant operating privileges to all license classes, from Novice Class (no longer issued) to Amateur Extra Class. However, existing Novice Class licensees would not be able to run as much power as the higher class licensees. This is akin to the now-in-place power restrictions for Novice Class operators in those segments in which they now have operating privileges. One of the possible scenarios is to limit the power output of all classes of operators for a period of two years to determine the extent of any possible interference between amateur radio operations and other services. It is suggested that, for the initial two years, higher class operators be limited to 200 watts output and Novice Class operators be limited to 25 watts output. After this initial "test" period the power output of operators holding Technician Class through Amateur Extra Class licenses would be increased to the full 1500 watts now allowed on other bands (excepting the 60-meter and 30-meter bands) and Novice Class operators would be increased to 200 watts output. I visualize being able to utilize the same modes as now allowed on 6 meters and 2 meters. Unlike those bands, I also do not visualize having CW only for the first 100 kHz.

Although preferred, the Amateur Radio Service does not have to have a "primary" classification. That is, amateur radio could be granted secondary use like that which is now granted in the 70-cm (420-MHz to 450-MHz) band. By granting secondary use, the FCC would not have to make changes in any regulations concerning other radio services. This would make allocating the new 4-meter band considerably easier for the FCC.

The availability of equipment is now scarce, but not absolutely unavailable. There are units available to commercial users in the 72.0-MHz to 76.0-MHz range which certainly could be retuned down to the 70.0-MHz to 70.5-MHz segment.

Also, it would be very easy for equipment to be homebrewed. Additionally, there are a few European companies that are making equipment for the 4-meter band.

Several people have criticized the petition for being "too simple." However, I have been "dealing with" the FCC for several decades and have been successful in the past with proposals that were brief and not filled with "legalese." Sometimes I believe that the FCC staff appreciates proposals that are straightforward and do not require a law degree to interpret. Of course, whether or not the FCC will even issue a Notice of Proposed Rulemaking on this proposal remains to be seen. Again, there are those who have said that even sending the petition to the FCC was a "waste of time." However, there are those of us who say that if there is no request made, then there is definitely no chance of getting a new band. Besides, the total cash outlay was for the paper on which the petition was printed, for a manila envelope, and a couple of first-class stamps. For such a little investment the possible rewards are very great.

For those who wonder exactly what "good" having a 4-meter band would be, there are several reasons. First, having additional bandwidth available is always a good thing. Next, the frequency range is low enough such that building homebrew equipment would not be that challenging; it would be a lot like building equipment for the 6-meter band. Then, from time to time, there is excellent propagation much like on the 50-MHz band. In years past, before amateur radio operators in the United Kingdom got 6-meter privileges, those of us in the United States used to work cross-band from 6 meters to 4 meters. Somewhere I still have a receiving converter that took 70 MHz down to 28 MHz.

The lower television channel frequencies are going to be "re-farmed," and I believe that the Amateur Radio Service is in a position to "get a piece of the pie." Securing the 4-meter band, because it is becoming an international amateur band, is, in my opinion, an excellent project that can reap many benefits for amateur radio.



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EMERGENCY COMMUNICATIONS

The Role of VHF in EmComm

Amateur Radio at Its Best

For me, the devastating earthquake in Haiti in January reaffirmed the validity of our hobby and how much we bring to the world community. The volunteer spirit of the many emergency amateur radio operators and MARS operators continues to make me proud of those who serve for the good of others less fortunate.

There are many who are still in Haiti helping, but I would like to tell you about one such station with many operators: WX4HNC. This is the amateur radio station at the National Hurricane Center located on the campus of Florida International University (FIU) in Miami, my hometown. This station has been providing emergency communications to a major university medical field hospital in Port-au-Prince, Haiti. This hospital, as of this writing, has performed over a thousand operations and is helping hundreds on a daily basis.

The ham radio club has installed two completed HF/VHF/UHF radio stations with multiple antennas at the field hospital and at the university's Miami/Haiti Command Center in order to assist in the massive humanitarian effort still under way. Volunteer teams of ham radio and MARS radio operators have been deployed on a weekly basis to operate the station in Haiti for five weeks at a time, even though their expenses have gone beyond their initial equipment grant and the club's savings. Many of the volunteers have paid their own way to Haiti, suffered through multiple vaccines, and carried over a hundred pounds of equipment, but they do not complain. This station is asking for your help by donating to their non-profit organization. Please donate what you can to this worthy cause at <http://www.fiu.edu/orgs/w4ehw/>. No, that is not a typo, just the station's old callsign.

It is important to note that the Chief of the International Bureau for the FCC, Mindel DeLaTorre, commented on the FCC blog, "The amateur radio community is also contributing to the relief efforts. In the aftermath of the earthquake, the amateur radio communities in Haiti, the Dominican Republic, and elsewhere have dedicated equipment and spectrum resources to the relief efforts."

My hat is off to all who have shared their time, money, and resources during this time of need.

My EmComm Home Away from Home

I just bought another antenna for my trailer. It's a three-element lightweight beam. In addition to that, I have a 2-meter/440-meter J pole and a 6- through 80-meter screwdriver mounted on the ladder for when we stop to stay somewhere.

During Field Day I will be testing it out near the beaches of the Puget Sound north of Seattle and just south of the Canadian border. That's what Field Day is for, right!?

I will be adding both solar and wind power to the trailer this year. Here in the Northwest the sun does not always shine, but



WX4NHC team volunteer Louis Cruz, N4LDG, took this picture of U.S. 82nd Airborne medics assisting an injured woman in Haiti in January. "Conditions there are critical," said Cruz, who trains and teaches emergency preparedness, information security and crisis management negotiations for the U.S. government. (Courtesy of N4LDG)

you can be sure to get wind, especially on the beaches. My intent is that in the event of an emergency, I can live off the grid if I have to.

What Could Possibly Happen?

This brings up something that I have been thinking about and would love to hear your opinion. First you need to know that I am a lover of technology. I have an Apple computer, a laptop running Windows® 7, another laptop running Windows® XP, and a netbook running Linux. I really enjoy utilizing many different programs for amateur radio and for emergency communications. I have even tossed around the idea of playing with some programming languages such as Python. At my job I am presently working with Radio Over IP (ROIP), and I love it. I believe in Software Defined Radio (SDR), though I do not own one.

Here is the issue: Based on what we know today, there are two possibilities out there. One is a cyber attack on our electrical grid. As much as we would like to believe that our electricity will always be there, we should be prepared just in case. A Chinese student has developed a paper showing two differ-

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ent attacks that can literally take down our entire grid, showing just how vulnerable we are. Anyone reading the news today knows that we are constantly under cyber attacks that seem to be coming from either China or Russia.

Another possibility is a nuclear weapon detonated miles above an area, causing an electro magnetic pulse (EMP). Over California it could shut down most of the West Coast as it would shut down the grid as well as all electronics. In this type of scenario only the old boatanchors such as those made by Drake or Heathkit brand names, to name only two, may work, but no one knows for sure.

I know that all of this sounds like I am preparing for the end of the world, but I am not. I like to think to the extremes. I do not believe a cyber attack or EMP will occur, but since it is possible, I feel the responsibility to my family to prepare at some level. It is no different than preparing for the next major earthquake here in the Northwest. An earthquake could occur today or not for another hundred years, but should I wait until it actually happens and then hope for the best? I don't think that would be wise.

The real problem comes down to our dependency on the internet. Obviously, ROIP will not be available during any of those scenarios, but many police and fire departments utilize this type of system. As we become more dependent on those types of systems, the radios we know today will become obsolete. That in itself is not a real problem, as SDRs are becoming more and more refined. ROIP, though, is dependent on the internet, and if that goes down, so will ROIP.

How About Some Good News?

After a long hiatus, it seems that more and more manufacturers are bringing back radios for 222 MHz. Why is that good news? 222 MHz was dying in this part of the country. It was not being used, and about eight years ago there were several companies attempting to access that band for commercial services. Lately there has been a resurgence in the use of this band, and apparently many of you petitioned companies out there to build or bring back the radios for this band. I am all for it and hope to choose my radio soon.

Until next time, remember what the Boy Scouts have known for over a hundred years: always "Be Prepared."

73, Mitch, NA7US

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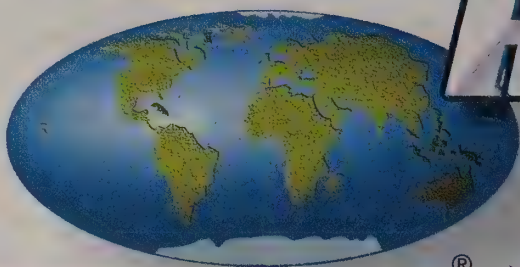
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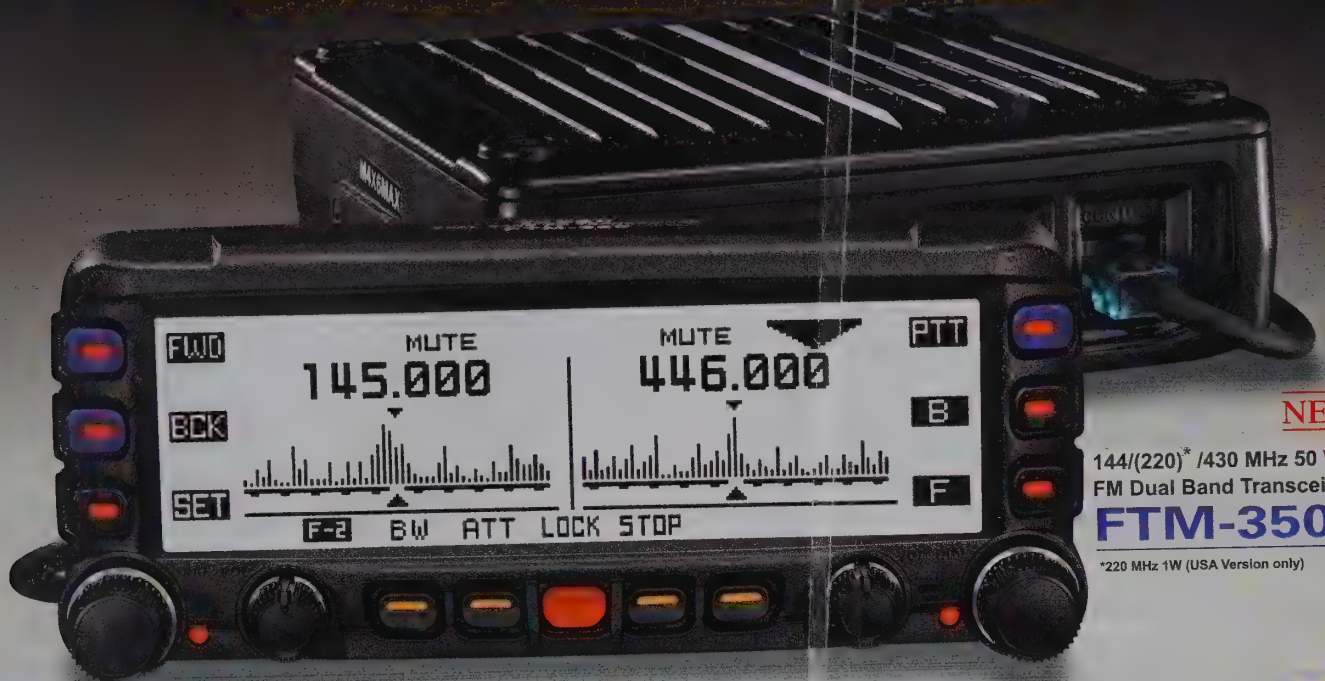
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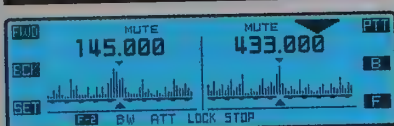
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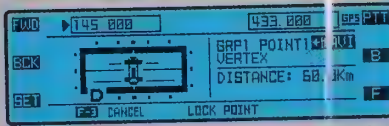
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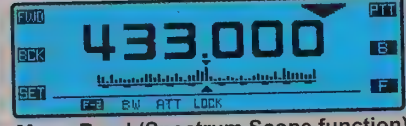
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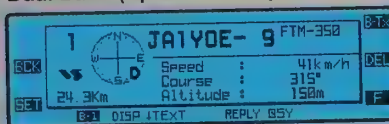
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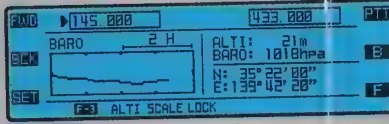
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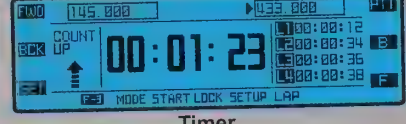
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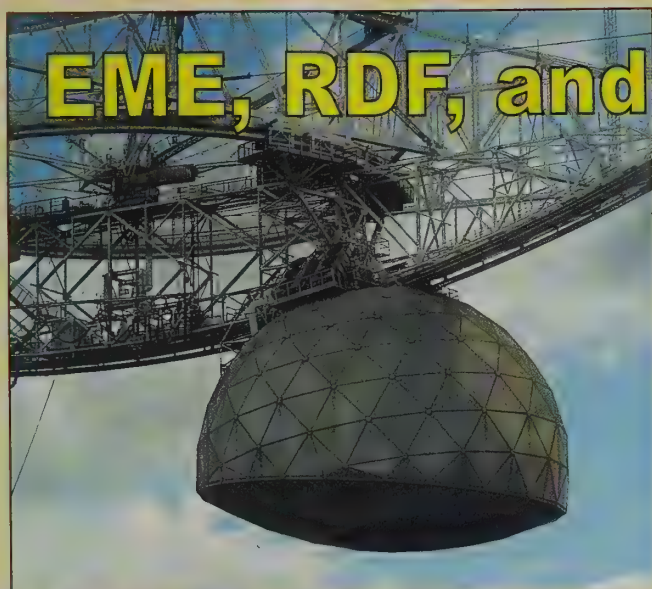
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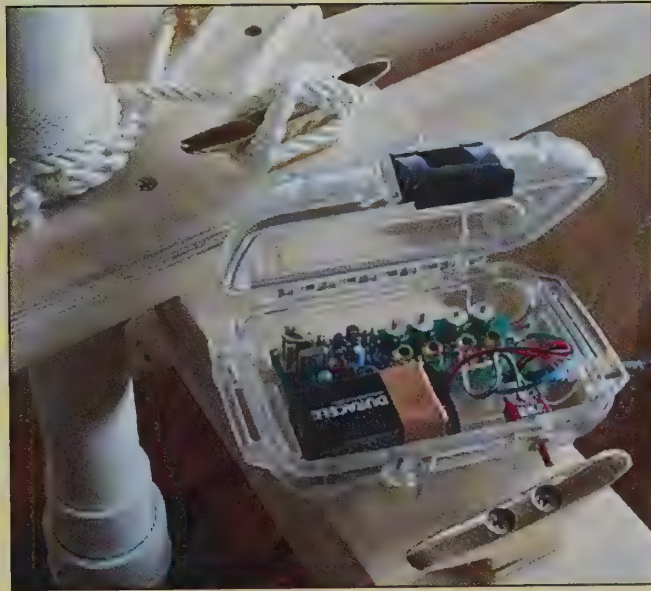
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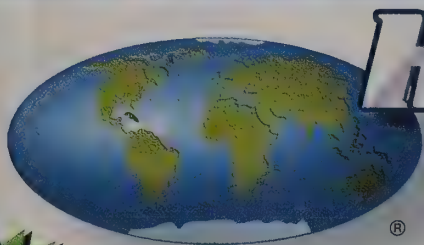


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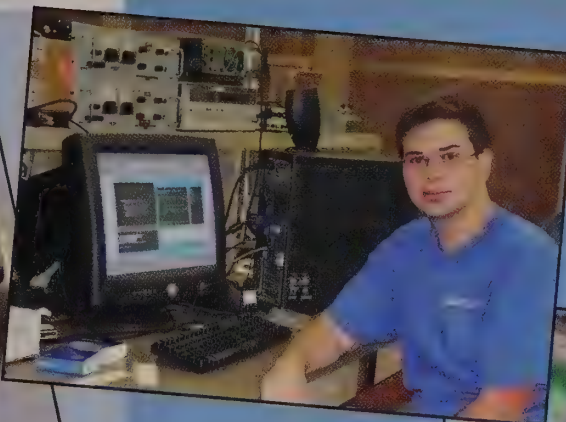
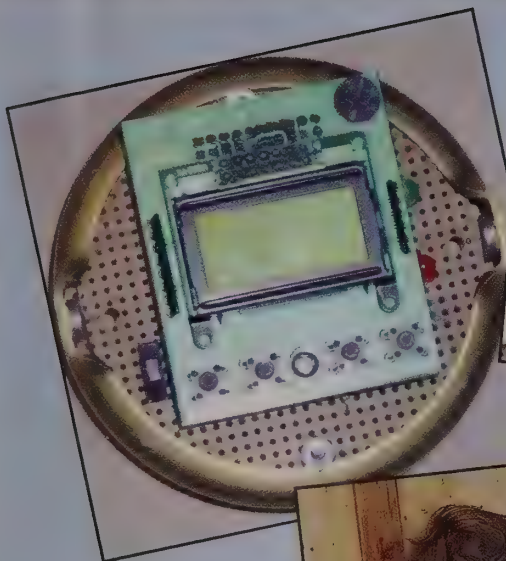
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CQ VHF Ham Radio
Above 50 MHz

LINE OF SIGHT

A Message from the Editor

Echoes of Apollo: The Parkes Dish Story

Beginning on page 6 in this issue you find Pat Barthelow, AA6EG's summary of last year's Echoes of Apollo very successful, worldwide EME operation. In his article you will also read a bit of history of the Apollo 11 television transmission and the tremendous role that Australia played in making it possible for us to see the live pictures from the Moon on July 21, 1969. Buried within Barthelow's article is this URL: http://www.publish.csiro.au/?act=view_file&file_id=AS01038.pdf, which is a pdf of John Sarkissian's paper "On Eagle's Wings: The Parkes Observatory's Support of the Apollo 11 Mission."

Sarkissian's paper is a fascinating summary of the role that three of Australia's giant dishes played in tracking and broadcasting live pictures from Apollo 11's Lunar Module. He points out that when the TV camera on the Lunar Module was switched on (by activating its circuit breaker), three dishes received the signals simultaneously. They were Goldstone, Honeysuckle Creek, and Parkes. NASA began the broadcast by choosing the Goldstone received TV signals first. For the first few minutes of the broadcast, NASA alternated the signals between those received by Goldstone and Honeysuckle Creek. After 8 minutes and 51 seconds, the Parkes signal was used and they stayed with it thereafter. The paper is rather lengthy, 25 pages long. However, I have summarized some of the main points (and have included the name of the third Australian giant dish that was used in Apollo 11 communications) in the March 2010 VHF Plus column in *CQ* magazine.

Regarding the photograph of the Parkes dish that appears on page 6, I am deeply grateful to Gabby Russell, the Communications Officer, Susan McMaster, the General Counsel, and Kim Higgins, the Personal Assistant to the General Counsel for the Commonwealth Scientific and Industrial Research Organisation (CSIRO) of Australia for their gracious assistance in locating and granting permission for our publishing that photo. All

three of them were most helpful in their assistance with the photo, and also Gabby was the one who highlighted Sarkissian's paper for me.

Echoes of Apollo 2010

In his article Barthelow also announces this year's Echoes of Apollo event. Taking place over the weekend of April 16–18, it will be in honor of Apollo 8. Again, it will be an EME event with participation encouraged by the big dishes. This year's event will include Arecibo, which is expected to be on the air on its favorite band, 70 cm.

If you have not seen a picture of Arecibo, take a look at Keith Pugh, W5IU's Satellite column, beginning on page 44. He had the good fortune to visit Arecibo as part of a QCWA cruise to Puerto Rico.

New Authors, New Column

With this issue we introduce two authors who are new to this magazine: Rick Campbell, KK7B, and Tom Dean, KB1JJ. Rick is one of the most prolific writers and experimenters in our hobby. He states that along with our amateur radio license comes a mandate to design, build, and experiment. He begins a series of introductory experimental articles focusing on how easy it is to get on 6 meters CW QRP starting on page 27. Look for future articles on easy experimental ideas for the VHF-plus ham.

Tom takes over as the ATV columnist from Miguel Enriquez, KD7RPP. Tom is a junior at the United States Military Academy and a member of the Academy's amateur radio club. Concerning the club's VHF-plus activities, Tom writes the following:

The USMA Amateur Radio Club has been working on a BalloonSat project over the course of this past year. We are currently hoping to launch in mid-spring this year. The project will fly various payloads which have been built as a joint project between the Academy's Amateur Radio, Astronomy, and Electronic Experimenter's Clubs. Payloads will include ATV, APRS, and packages to measure prop-

erties of the atmosphere. The launch will either take place in Colorado or the Northeast.

More on the Academy's ARC can be found in the March 2010 VHF Plus column in *CQ* magazine.

Tom begins his column on digital amateur television (D-ATV) on page 50. With each successive installment of his column we will follow Tom as he develops his D-ATV station. Also in this issue, Miguel assumes his new duties as the Education columnist (titled The VHF-Plus Classroom). In his first column, which begins on page 74, he discusses the vital role of Elmers in the classroom.

Eighth Year

With this issue of *CQ VHF* magazine we have completed eight years of publishing the relaunch of this publication. It has been fun and it has gone fast. In reflecting back on these past eight years, I think that the most fun I have is going to the various conferences, hamfests, and club meetings, as well as balloon launches. I have met so many new people in our niche of our hobby. I have gone to various parts of the country and visited many cities.

While my travels have been fun, I think that the most rewarding aspect of this position as your editor is the finding and developing of new writers. Our writers cover a number of topics, from history to all of the different technical niches, to fun operating, to emergency communications, to experimentation and design.

While I believe that we have the best authors in amateur radio, I am always looking for new talent. If you have a story to tell, I would be delighted to have you join us and share your story.

Happy New Year

Even though you are receiving this issue in February, I believe that it is not too late for you to receive a wish for a Happy New Year. May this coming year be full of fun and excitement as you pursue your interest in our niche of our wonderful hobby. Until next time...

73 de Joe, N6CL

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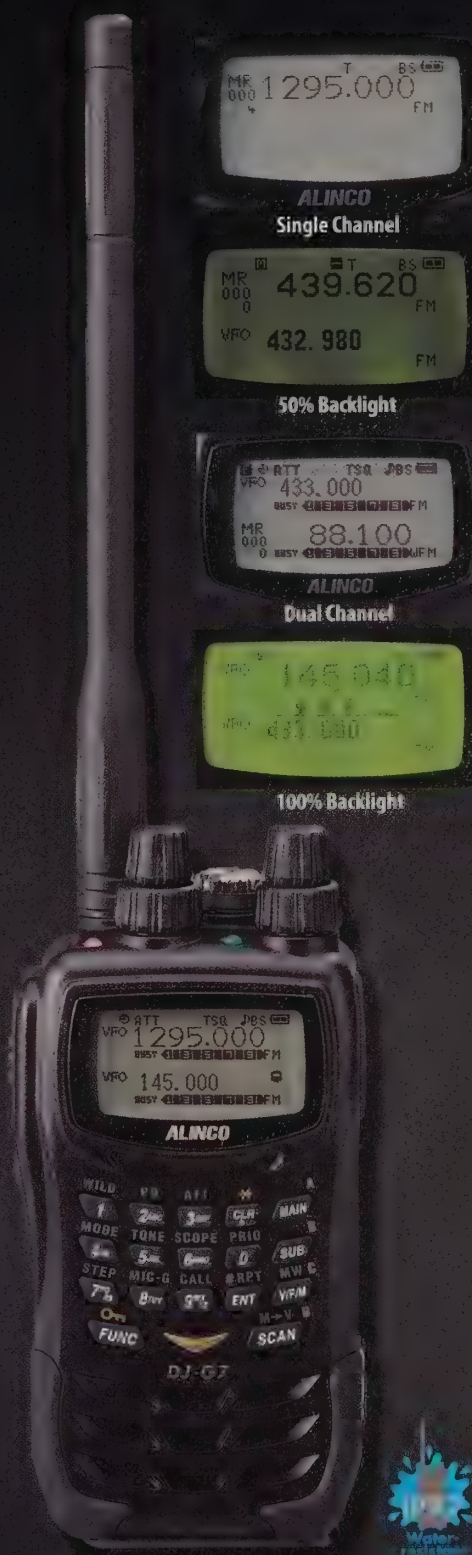
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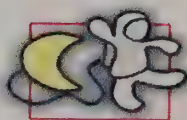


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CSIRO's Parkes Dish was the focal point of the 2000 movie *The Dish*, which was about its involvement in the reception of Apollo 11's transmissions. (Photo credit: David McClenaghan, CSIRO)

Echoes of Apollo 2009/2010



ECHOES
OF
APOLLO

Last year's Echoes of Apollo EME event was a worldwide success. Here AA6EG provides a bit of history associated with the large dishes, summarizes some of the main operations, and announces the year's EOA event.

By Pat Barthelow,* AA6EG

“It was the best of times, it was the worst of times . . .” Charles Dickens wrote. As I recall, from my limited perspective, the journey taken by so many that helped in the success of Echoes of Apollo 2009, I settle into some warm and fuzzies, also accompanied by a few more stress wrinkles here and there that appeared on me during the journey. However, if feedback is any indication, EOA 2009, aka World Moon Bounce

Day, an EME/Science outreach event and a concept for future EME events, did very well.

Most folks involved had a very enjoyable time. For EOA to have happened, a huge amount of new ground had to be learned, by me in particular, as I am a newcomer to EME and approach it from an unusual background, in which my non-ham big-dish experiences encouraged me to apply big dishes to EME in a way not commonly done before. From my experiences with EOA I have learned that today, more than ever before, there are under-utilized or even abandoned large dishes eminently suit-

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able for EME applications that can be sought out and used by the amateur radio community.

EOA Moonbounce Origins and Objectives

Fundamental to the EOA event origins was the realization that EME has a certain snap and pizzazz to up-and-coming technophiles that could attract them to modern ham radio, and maybe if experienced by the very young, could set a waypoint in their educational development and life experience leading them to science, space, and technology careers. In addition, the seasoned veterans of EME, a rather small but technically astute group of the amateur radio community, could have a bunch of fun with the unusually strong SSB signals provided by the commercial dishes—such as SRI near Stanford University; the dish at the University of Tasmania at Mt. Pleasant; and Dwingeloo in The Netherlands—which were brought in to participate along with the big dishes already out there custom built by so many in the EME community.

For details of early events leading up to EOA, get a copy of the Spring 2009 issue of *CQ VHF*. My chance cyberspace meeting with Robert Brand and his colleagues of On-Time Virtual Assistant (OTVA, see <<http://www.otva.org>> and <<http://exotc.com/wordpress/?p=254>>) formulated the basis for creating EOA. OTVA has a lot of seasoned individuals with history and experience in the Apollo program and was looking to celebrate the coming anniversaries of the Apollo Moon missions. I suggested to Robert that a world moonbounce event might dovetail nicely with their celebrations, especially if we could get the Parkes or Tidbinbilla (Honeysuckle Creek) dishes to participate. Those two dishes in southeast Australia provided critical capability of ground-station connectivity with the Apollo Moon missions and still exist.

Apollo 11's Moon Landing, Moon Walk Video

The initial Apollo 11 Moon landing video was received from the moon by the 26-meter Honeysuckle Creek Dish, part of the NASA space tracking network, Australia, which, by the way, was moved in the 1980s to Tidbinbilla at the Canberra Space Complex and very recently retired.

Speaking of those under-utilized or even abandoned large dishes mentioned

above, here is an opportunity for some local Australian ham clubs. Perhaps they could propose to use the historic Honeysuckle Creek Dish for EME and science outreach.

CSIRO's Parkes Dish had a movie made about it called *The Dish*. Much creative license was taken in the movie details of how Parkes operated during the Apollo 11 mission. However, the movie was very entertaining, and the real shots on/at the dish were spectacular.

There is another very accurate story of the Parkes and Honeysuckle Creek coverage of Apollo 11 on the web. One of the best technical write-ups available is entitled "On Eagle's Wings" by John Sarkissian of Parkes (see <http://www.publish.csiro.au/?act=view_file&file_id=AS01038.pdf>, <http://www.parkes.atnf.csiro.au/news_events/apollo11>, <<http://members.tip.net.au/~mdinn/TheDish/>>, <<http://www.honeysucklecreek.net>>. See a great walk through videos of

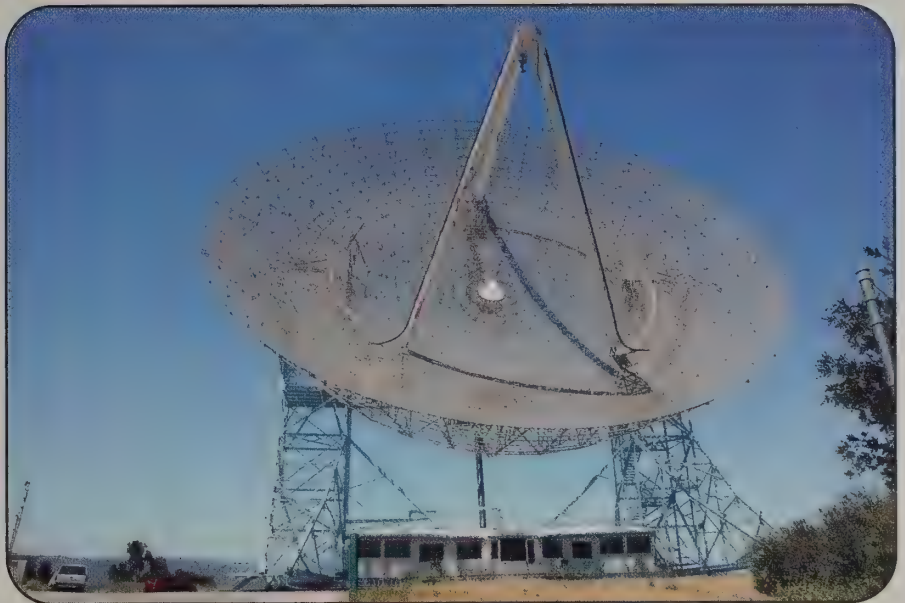


Photo of the SRI dish used during the EOA event. (Photo courtesy of Jim Klassen, N6JMK)



The author standing next to the SRI dish feed horn. (Photo courtesy of N6JMK)

the Parkes dish at: <<http://www.youtube.com/watch?v=VsoIeojQCcc&feature=related>>. In retrospect it is astounding to note that NASA initially did not plan to have a camera aboard Apollo 11 to record the momentous moon-landing event.

The SRI EOA Team

I was fortunate enough to be able to assemble a California team of seasoned radio amateurs with moonbounce experience and was able to connect with some highly skilled big-dish professionals who all were essential to make the California EOA operation happen successfully. Special thanks go to many people whose expertise, experience, and hard work were applied in a relatively short time period. The whole team turned out to produce an awesome performance during EOA.

A phone call and a proposal to management at the 45-meter SRI dish resulted in granting permission to use the dish in EOA last June. Thank you, SRI! Dish management and SRI technical staff were immensely helpful, in some instances even volunteering their time for feed mounting, setup, and tweaking, and in overcoming a (typical) host of technical challenges encountered during EOA, as well as the trial-run event which took place about one month prior to EOA weekend. The technical challenges, procedures, construction, measurements, repairs, and modifications encountered and overcome by Team SRI—both the hams and the SRI dish staff—if reviewed in detail could fill another five pages of this magazine. We won't do that, but would be glad to discuss the details "off line," so to speak. Send me an e-mail at: <apolloeme@live.com>, or visit my blog: <<http://www.echoesofapollo.wordpress.com>>.

Then, of course, my thanks to lead ham engineers and "Team SRI" for sourcing and constructing the SRI station: Dave Smith, W6TE; Lance Ginner, K6GSJ, master systems engineer and troubleshooter; and Mike Staal, K6MYC, EMEer extraordinaire and owner of M² Antenna Systems, Inc. Dave brought aboard select ham team members Jim Klassen, N6JMK, and Wayne Overbeck, N6NB. John Morrice, K6MI, loaned some of the RF lineup feeding the dish. John, Dave Smith, and Mike Staal provided the essential, expensive pieces in the 23-cm RF chain at SRI and the expertise to assemble, troubleshoot, repair, and make it work. Mike's high-

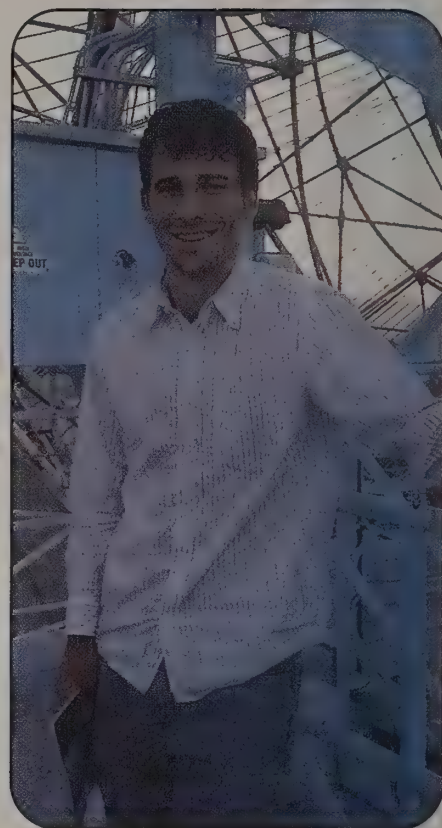
power APX-4 with six each 2C39 water-cooled tubes in an array cavity came back to roost at SRI, where it was used for EME by Mike at SRI in the 1960s. During the course of EOA, the APX-4 suffered some arc-over problems, and we went back to a lower power SSPA (solid-state power supply). Dr. Michael Cousins, of SRI, obtained for us a corrugated Horn from the inventory at SRI for a 23-cm feed. At the initial shakedown test, Dave, W6TE, and the SRI crew set up the horn for linear polarization, which worked, but was a compromise. Later it was equipped for circular polarization for the main event. Jim, N6JMK, oversaw site logistics and Team SRI safety. Well-known moonbouncer from "Down Under" Doug McArthur, VK3UM, did a wonderful job organizing EOA EME skeds and real-time news updates during the event, and as always provided a booming EME signal from his station in Glenburn, Victoria, Australia.

Dr. Dave Leeson, W6NL—a well-known ham, Stanford professor, and W6YX Ham Radio Club Advisor—was a wise mentor and guardian angel to us "newbie" and veteran EME hams at SRI. Looking over our shoulders, he contributed sage project management advice during the dynamic and often high-pressure preparation periods leading up to EOA. Lance Ginner, K6GSJ, with some fifty years of history in ham satellites, proved to be essential to the team as a seasoned technical support engineer who saved the day more than once with his expertise. He also had a dream microwave shop in his nearby home garage with a gold mine of spare components, including relays, preamps, etc. Lance and his incredible wife Wanda were also fabulous hosts and provided the SRI team with an unforgettable poached halibut dinner on their outdoor patio within view of the SRI dish. Thanks, Wanda and Lance!

All of these folks played fundamental roles in the success of the SRI operation during EOA 2009.

Eric Stackpole, KF6JBP A New Moonbouncer

At the SRI facility during EOA we welcomed a young ham visitor, Eric Stackpole, KF6JBP. Eric recently graduated from San Jose State with a degree in mechanical engineering, and he provided us with a surprise, heartfelt validation of our science outreach objectives. Eric did some moonbounce operating at SRI,



Eric Stackpole, KF6JBP, who wrote after his EME experience, "EME rocks my world." (Photo courtesy of KF6JBP)

his first. The mile-wide grins from Eric during EOA were priceless.

Eric has since spent an internship at NASA-Ames designing CubeSat de-orbiting systems. He is now very busy in mechanical engineering graduate school, with a full NASA grad school scholarship. I am sure that in the future you will see great contributions in the area of science from Eric, probably things related to space communications or rocket science. I plan to bring Eric on board for future EOA team events. I sent Eric the YouTube EOA video produced by the Team Tasmania hams, which includes Eric's voice as heard via EME from SRI at the Tasmania Mt. Pleasant dish. Here is Eric's e-mail to us after seeing that video:

This is great! I CAN HEAR MY OWN VOICE FROM THE MOON! I forwarded it to basically everyone I know. I wanted to thank you not only for showing me this, but also once more for organizing the event. As I mentioned before, that evening I spent during Echoes of Apollo probably changed my life, and I will remember it forever. Please let me know of any other activities like it. EME rocks my world! 73, Eric.

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Of course, the SRI dish and team were just one of the players in the worldwide EOA event, and thanks have to be voiced to the many participants who made the EOA event a success. I am sure all the EOA EME players around the world have lots of their own stories to tell.

EOA/EME Chur, Switzerland, HB9MOON

Christoph Joos, HB9HAL, aka HB9MOON, really put together a great team which built and runs the great 10-meter dish EME station, HB9MOON, in Chur, Switzerland (<http://www.radiosky.ch>). Chris and his team initiated a wonderful public-relations effort and had about 300 visitors during the EOA event, many of them youngsters, and generated a Swiss TV national network news story of their participation. See the network TV coverage of the HB9MOON participation at: <http://www.youtube.com/watch?v=BUVoiEJd86s&translated=1>.

During EOA, Christoph got permission from the government authorities to broadcast children's messages of peace via moonbounce from the HB9MOON station. There is a recording off the moon of those broadcasts at <http://www.radiosky.ch/Podcast/Friedensbotschaft%20HB9MOON.mp3>. Other exploits of HB9MOON can be seen on YouTube as well.



A nighttime view of the HB9MOON dish in Switzerland. (Photo courtesy of Radiosky)

Dwingeloo Dish, The Netherlands

The Dwingeloo 25-meter dish, lovingly restored and operated under the management of the CAMRAS group, and its return to use from radio astronomy to EME, is and has an amazing story that can fill another issue of this magazine. Suffice to say that Jan Van Muijlwijk, PA3FXB, Dick Harms, PA2DW, Robert Langenhuisen, PAØRYL, and a large, dedicated volunteer team have put years of work into bringing the historically significant Dwingeloo dish back to service now as one of the most advanced and successful large EME dishes in the world, including on-line SDR EME receivers.

Tasmania to Dwingeloo via the Moon on .003 watts!

I think the 3-milliwatt QRPP EME QSO via JT65 between the Mt. Pleasant dish, University of Tasmania, and the Dwingeloo dish (<http://www.camras.nl>)



By special permission of the Swiss government children were allowed to send messages of peace from the HB9MOON station. (Photo courtesy of Radiosky)

in Holland stands out one of the real highlights of EOA, World Moon Bounce Day. Details on the Mt. Pleasant dish are at: <http://www.phys.utas.edu.au/physics/mt_pleasant_observatory.html>. A paper on recent activities at Mt. Pleasant can be found at: <http://ntrs.nasa.gov/archive/nasa/casi.ntrs.nasa.gov/20080032625_2008033028.pdf>.

Hobart, Tasmania Mt. Pleasant Observatory

The University of Tasmania's Mt. Pleasant 26-meter dish, in Hobart, originally was planned only to be a receiving station, as they had incredibly sensitive and expensive liquid-helium-cooled LNAs at the feeds for which they could not guarantee protection from damage if high power amateur transmitting equipment was used at the feed. These preamps had been used in the professional radio astronomy work at Mt. Pleasant.

Due to some careful and supportive analysis by Dr. James Lovell and his UTAS team, the situation was analyzed and it was decided that some very low TX power could be done without harming the LNAs and set up of a 10-milliwatt station for EOA was authorized.

Rex Moncur, VK7MO, Justin-Giles Clark, VK7TW, and the University of Tasmania staff technician Eric Baynes, VK7BB—who I will refer to as Team Tasmania (TT)—essentially built the EME QRPp station at the dish, experiencing the trials and travails of breaking new ground (of any first-time EME station) at the Mt. Pleasant dish. Team Tasmania's ambitious work under tight deadlines and working around the observatory's professional bookings included: building and trying a couple of different feed antennas, including a three-turn helix and a septum polarized choke feed; building down converters (VK7BB), 1296-MHz bandpass filters; and bringing in Rex's preamplifiers and a GPS frequency reference.

TT had an interference problem from the Hobart Airport, which they solved with bandpass filters. TT EME tests with Dave Scott, VK2JDS, still showed some station performance deficits, which TT brainstormed and quantified using sun noise measurements.

However, lots of tweaking later, including design and refabricating a new mount for a new septum polarized choke feed succeeded. The septum polarizer with choke feed once mounted and

with a lot of work from TT achieved a sun noise level of 25 dB, a few dBs from ideal.

Eric, VK7BB, was the go-to guy for the antenna work. Those of us who have been there and done that are familiar with the climbing harness, safety hooks, man lifts, and the rest of the drill, and know from experience that there is rarely any

such thing as a 1-hour, or usually even a 3-hour, rigging visit with feed modifications and can really appreciate the amount of work performed by Team Tasmania.

After all that work, TT conducted successful SSB receiving tests with Doug, VK3UM, and his 400 watts fed to an 8.6-



Christoph Joos, HB9HAL/HB9MOON, installing the OM6AA designed dual-mode, septum polarizer at HB9MOON's 10-meter EME station. (Photo courtesy of HB9HAL)



Dick Harms, PA2DW, at the controls of the Dwingeloo EME station. (Photo courtesy of CAMRAS)



Justin Giles-Clark, VK7TW, sitting on the floor of the Mt. Pleasant control room trying to figure out how to be able to transmit a signal and not blow out the liquid-helium-cooled LNAs. (Photo courtesy of VK7TW)

meter Kennedy (converted Apollo era surplus) dish. Then TT studied the possibility of 10 milliwatts of JT65 with Jan, PA3FXB, at the PI9CAM 25-meter dish in Dwingeloo. On World Moon Bounce Day they were able to do the first test of their JT65 setup, achieving -27.8 dB signal levels for Moon echoes after careful feed-position adjustments. Both dishes probably had a gain spec slightly higher than 50 dBi, which is normally unheard of gain at 23 cm in amateur EME. Early SSB QSOs at 5/7 with Doug, VK3UM, brought smiles and squeals of delight from the kids who heard their own names coming off the Moon's surface.

Dave, VK2JDS, had ham copyable 5/2 SSB signals at Mt. Pleasant, not quite copyable by the kids, so they went to JT65 and continued to awe the kids who now saw (and photographed) their own names *printed* coming off the Moon. Eric Stackpole, KF6JBP, at SRI was copied at 5/7 for a short while until another preamp went, and the SRI team had to do a repair. TT carried on, with visits from the media and QSOs with VK3UM, with all being suitably impressed.

The TT QRPp JT65 continued at 30 milliwatts with the European window opening, initially hearing Dan, HB9Q (15 meter dish), who reported a -23 dB signal, with -29 dB at 10 milliwatts. Then the PI9CAM, 25-meter Dwingeloo dish, was worked first at 10 milliwatts then reduced to 3 milliwatts, producing signals of -26 dB. A try at 1 milliwatt was not successful. The 3-milliwatt EME QSO surely must be a world record! Three milliwatts is quite a bit less power than a single LED keyfob flashlight! TT produced an excellent video documentary of their participation: <<http://www.youtube.com/watch?v=AHGXp4Afr4g>>.

Rex and Justin's article on the Tasmanian-Dwingeloo QSO was reprinted from the Wireless Institute of Australia's *Amateur Radio* magazine in the September 2009 issue of *CQ* magazine in the VHF Plus column by N6CL. Accompanying

that article are comments from the Dutch side that appeared on the Moonnet reflector.

WIRED Magazine and The New York Times

On both the SRI trial run and the EOA weekend Lisa Sonne, a reporter for *WIRED* magazine, attended, took notes, did interviews, and did some guest-op EME herself. Lisa joined Ashley Vance, a reporter from *The New York Times* and a NYT photographer, and they all interviewed nearly the entire SRI team, including the SRI professional staff, and produced two stories for *WIRED* (<http://www.wired.com/>); Wireless Institute of Australia's *Amateur Radio* magazine, Volume 77, Number 8, August 2009, and <wiredscience/2009/06/moonbounce/> and <<http://www.wired.com/wiredscience/2009/07/ham-operators-shoot-the-moon/>>. EOA made the June 27, 2009 *New York Times* front page and had considerable photos and "column inches" (<http://www.nytimes.com/2009/06/27/technology/27moon.html>).

Apollo 8 Astronaut William Anders on EME

During EOA, Apollo 8 astronaut William Anders, from his home in the state of Washington, joined us in an EME voice chat. (http://en.wikipedia.org/wiki/Apollo_8). Anders is very well known for taking the stunning and thought-provoking "Earthrise" photo from his Apollo 8 spacecraft while orbiting the Moon. Anders' EME QSO was captured and preserved by Ben Bailey, W4SC, who was at the station of well-known EMEer Joe Demaso, K1RQG, who, from Maine, monitored the Anders EME QSO. The two EME stations in QSO were SRI and Joe Martin, K5SO, in New Mexico. Astronaut Anders

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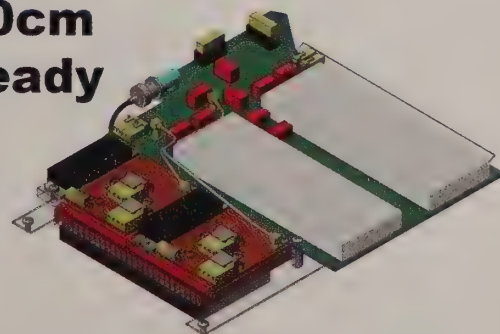
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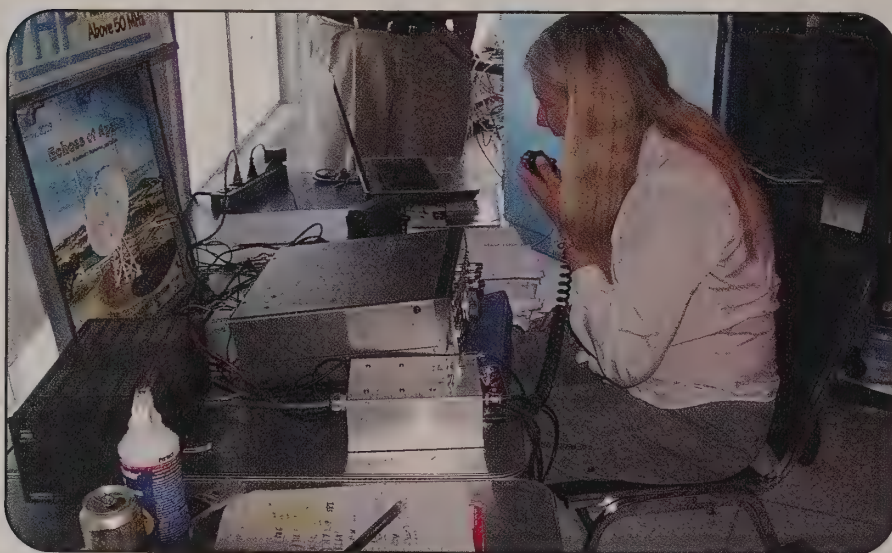
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Dave Smith, W6TE, demonstrating EME to Ashlee Vance, The New York Times reporter. Lower left is Jim Wilson, the NYT photographer. (Photo courtesy of Dave Smith, W6TE)



Lisa Sonne, a reporter for WIRED magazine, having an on-air EME conversation with Apollo 8 Astronaut William Anders. (Photo courtesy of N6JMK)

was on a telephone link to K5SO. Thanks a ton to all of you for capturing that astronaut EME QSO. The audio file of astronaut Anders' QSO is at: http://k5so.com/K5SO_W6SRI_D2000Hz_20090628_171651.wav.

EOA 2010: Arecibo

EOA 2010 is set for April 16, 17, and 18 starting at noon on Friday and lasting through 17:00 Sunday, both West Coast time. This year will have on board the highly endangered, biggest EME dish of all at the Arecibo Observatory in Puerto Rico probably on 432 MHz but possibly other bands. As this article was being

prepared, discussions with Angel Vazquez, WP3R, and Dr. Nolan were ongoing. As I finished this article in early January I received word that they were very willing to join EOA on 432 MHz with a possibility of multiple bands.

I would encourage the ham community to become advocates for preservation of Arecibo, now at serious risk of closing. See these websites for Arecibo advocacy and networking: <http://arecibo-science.org/Newsletter.html>, http://www.planetary.org/programs/projects/advocacy_and_education/space_advocacy/20080703.html, http://setiathome.berkeley.edu/arecibo_letter.php, <http://www.arecibo-observatory.org/friends.html>, and https://www.policyarchive.org/bitstream/handle/10207/19327/R40437_20090305.pdf.

Final Thoughts

EOA 2009 was a wonderful, challenging journey for all involved, with *all* being the keyword, because all of them should be proud of their EOA and lifetime EME accomplishments and acknowledged for those accomplishments. Many people have been named and acknowledged here, but in the limited available print space many more have not and cannot be acknowledged in this article. The use of internet URL references in this article is a big multiplier for distributing content and acknowledgement of other's accomplishments. Please use them, and communicate and teach one another. Spread the word.

If you embark on a similar adventure, while you are doing so, please realize that the risks and challenges taken and overcome towards an objective are not only technical, but also personal and sometimes professional. Realize that anyone in a professional position to grant favors to a (any) visionary ham project is taking risks, has a boss, and has his or her own set of in-house issues—aka politics—to deal with and that their decisions have consequences, hopefully good ones.

As a result, sometimes some of the heroes and angels who take those risks on your behalf would prefer to remain unnamed. Find out if that is the case. Understand that when you are breaking new ground, often you are also treading on ground (turf) that has been groomed by others over a long time period. When you hear (hopefully before) the 12-gauge pump cycled, slow down, become a diplomat, and become friends with your new neighbors. Learn from them. Also, realize how extremely difficult it is to make everyone happy in a massive volunteer effort.

Try your best to go out of your way to acknowledge your volunteer teammates, since in the “real” world a lot of the acknowledgement is in the form of a paycheck, and that makes a lot of the blood, sweat, and tears of a job tolerable. Realize, as I have, that working with people in a large volunteer organization is very often far more difficult and time consuming than working with dBs, noise figures, Az and El, HPAs, and dish alignment.

Again, thanks to all who participated, and I look forward to hearing you off the Moon or perhaps on 20 meters CW soon.

Amateur Radio and the Cosmos

Part 3 – A New Dawn

Have you ever wondered about the origin of the term “sky noise,” or why the 10.7-cm solar flux is such an important measurement? Here WB2VVA discusses these items and much more about the sun.

By Mark Morrison,* WA2VVA

It was during a field trip to the local phone office when my classmates and I received our second Bell Labs experience, an early demonstration of the touch-tone and picture telephones. Of the former, we’d be challenged to see who could dial faster, the person using a touch-tone phone or a rotary. The rotary challenger put up a good fight, for everyone knew how to speed up the dialing process by forcing the dial in reverse, but it was a fight to be lost. The touch-tone phone just couldn’t be beat. Also, the picture phone, which seemed pure science fiction, would become a highlight of the New York World’s Fair in 1964. The connections of these innovations to our story may not be obvious, but the technology behind them was rooted in decades of mathematics and scientific research taking place at Bell Labs during the first half of the 20th century. Ever vigilant to provide the best phone service in the world, the many innovations and scientific breakthroughs at Murray Hill touched our lives in many unexpected ways.

In his book *Forty Years of Radio Research*, wireless pioneer George C. Southworth provides a rare glimpse inside Bell Labs, including the work of two associates, Dr. Harry Nyquist and Dr. J. B. Johnson¹. In 1928 Johnson theorized that all electronic circuits generated noise depending on their absolute temperature and the band of frequencies under consideration. Nyquist theorized that “Johnson noise” is a form of one-dimensional black-body radiation existing even in systems of such circuits. Although the weakest link would appear to be the “first circuit noise,” such as that of the antenna in a radio receiving system, Southworth wrote, “mature thought showed that the first circuit was really the medium to which the antenna was coupled. In particular cases the medium might include particular objects in interstellar space ... one of the most obvious heavenly bodies was the sun.”

In those days receiver noise wasn’t considered much of a problem, but once radar came on the scene, with weak signals awash in circuit noise, things changed quickly. Indeed, the signals of interest were so weak that even noise from celestial bodies, such as the sun and even the Milky Way Galaxy, had the potential to interfere with radar operations. It was J. S. Hey who first associated certain problems with British radar to noise from the sun rather than enemy jamming.

In 1942, Southworth pondered the work of an earlier physicist, Max Plank, who in 1901 revolutionized the world of

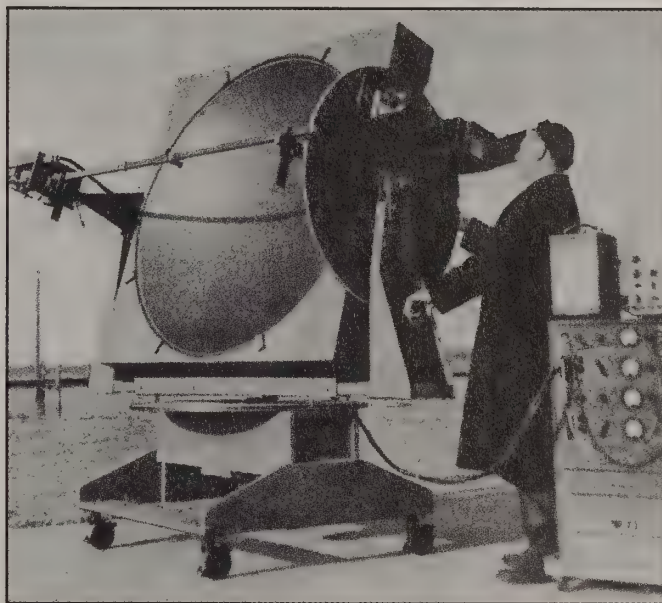


Figure 1. Monitoring and measuring solar energy, 1942. From Forty Years of Radio Research, by George C. Southworth. Note that this photo itself is referred to in the book at “Reprinted by permission from Scientific Monthly 82, 55-66, 1956.”

physics with his quantum theory for black-body radiators. This theory predicted “the total amount of [solar] energy falling on the earth” and “specified the amount of power contained in each unit bandwidth being sent out.” Although the amount of energy predicted to fall within the microwave region would be small, well below the noise level of a typical 1940s receiver, Southworth wondered if a “double-detection” receiver developed for waveguide research and “groomed” for low noise might do the job. Southworth connected this 9400-MHz receiver to a small parabolic dish using a section of waveguide and directed one of his associates, A. P. King, to aim the antenna toward the sun as shown in figure 1.

Almost immediately a small but definite increase in noise was detected, as indicated by a panel-mounted milliamp meter. However, there was more. Southworth knew that if the received energy could be measured, Plank’s theory could be used to predict the temperature of the object radiating it. Thus it was that on June 29, 1942 the first centimeter radio emissions from the

*5 Mount Airy Rd., Basking Ridge, NJ 07920
e-mail: <mark1home@aol.com>

sun were not just detected and measured, but the temperature of the sun was determined by radio. It is interesting to note that Robert H. Dicke, the same Princeton physicist who later confirmed the “Big Bang” noise detected by Penzias and Wilson, made a related instrument with the ability to switch the receiver between the antenna and a reference of known temperature, thus providing a means of calibration. Known as the Dicke Radiometer, this instrument allowed for much greater accuracy and was used by Dicke himself to measure the temperature of the sun and moon in 1945.

Much of the work of Southworth and Dicke went unreported due to the war effort and concerns that such information might reveal the state-of-the-art being achieved in the field of microwaves. However, this did not seem to apply to amateur radio operator Grote Reber, W9GFZ, who performed solar observations from his backyard observatory and reported on his work in important journals of the day. During this time it appears that Southworth corresponded with Reber, as did another Bell scientist Dr. Charles Townes, who it turns out was another neighbor of mine.

When Karl Jansky first detected radio signals of extraterrestrial origin, few astronomers gave it much attention. Later, when Reber detected radio emissions at even higher frequencies, first at 160 MHz and then at 480 MHz, most astronomers were still not convinced. However, two Harvard astronomers also with backgrounds in amateur radio did take notice and started to work on a theory to explain the origin of these signals. One was Fred Whipple, the well-known comet pioneer who also played a major role coordinating the observations of amateur astronomers during the International Geophysical Year (IGY) of 1957–1958. The other was Jesse Greenstein, Whipple’s student, who went on to become a well-known astronomer in his own right.

The inverse relationship between radio intensity and frequency established by the combined work of Jansky and Reber presented something of a dilemma to astronomers. According to Plank’s theory, the intensity of thermal noise should increase, not decrease, with frequency. The numbers from Jansky and Reber seemed to show otherwise, suggesting the source of these signals was something non-thermal. Although Jansky believed these emissions were related to ionized

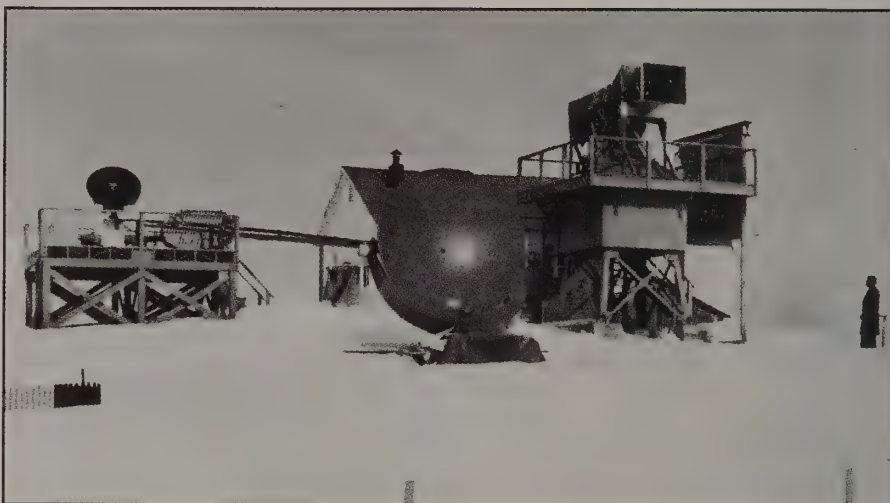


Figure 2. Dish used for 10.7-cm solar observations. Taken from a letter from Covington to Reber (<http://jump.cv.nrao.edu/dbtw-wpd/Textbase/Documents/grgc-covington-reber-12141951.pdf>).

gas clouds, other scientists—including Whipple, Greenstein, and Townes—continued working on the problem of trying to develop their explanation of the origin of these signals.

In 1946, while working at Murray Hill, Townes developed a theory that ionized gas would require much higher (meaning outer space) electron temperatures than were generally accepted at the time. Townes published his work in an article entitled “Interpretation of Radio Radiation from the Milky Way,” in which he mentions both Reber and Southworth.² In an e-mail to this author, Townes indicated that while Bell Labs didn’t hire many astronomers, when they did it was mainly for its microwave expertise. He also described an early interest in radios “as an amateur” and how he built one at the suggestion of a cousin who was an engineering professor.

By the spring of 1947, Reber was preparing to join the Bureau of Standards, including the relocation of his dish from Wheaton, Illinois to Stirling, Virginia. By joining the Bureau he would become more of a mainstream researcher, which was something of a disappointment to Southworth. In a letter dated March 13, 1947 Southworth remarked, “I must, however, confess to a tinge of regret to see you pass from the fast-thinning ranks of individual workers.³ Your ability to carry on with limited facilities has won the respect if not indeed the admiration of all who know about you.”

Two of the last contributions Reber made as an independent researcher were his observations of a solar burst at 480

MHz in November 1946 and his presentation of the paper “Solar and Cosmic Radio Waves” at the Joint I.R.E.-U.R.S.I. meeting held in Washington, DC that year. It was during that meeting when Reber met Karl Jansky for the first time, as well as another radio astronomer performing solar observations in Canada, Dr. Arthur Covington, VE5CC. In a letter from Reber to Jesse Greenstein dated May 16, 1947 Reber describes Covington as “a very smart fellow who is not afraid to get his hands dirty” and describes how Covington appeared to have detected the same solar bursts at 3000 MHz that Reber detected at 480 MHz.⁴

In an article called “The Development of Solar Microwave Radio Astronomy in Canada” Covington describes how his combined interests of astronomy and amateur radio, coupled with inspiration from Reber’s activities, got him into radio astronomy.⁵ In the years that followed, Covington would build several radio telescopes, first using parts borrowed from a surplus SCR-268 radar set as well as waveguide technology that just happened to operate at 10.7 cm. In November 1946, Covington used this equipment to monitor the sun during a partial solar eclipse and, using an optical telescope for comparison, observed how the solar flux changed as the moon covered a large sunspot. This suggested that sunspots were the source of high levels of radiation at 10.7 cm and, ultimately, that a relationship existed between solar flux and the sunspot number. Figure 2 shows a picture of the 4-foot dish used for Covington’s 10.7-cm solar observations (left side of

picture) as well as other equipment used by Covington at the Goth Hill Radio Observatory in Ottawa, Canada.

Although the familiar parabolic dish was used for Covington's 10.7-cm discovery, later he used a 150-foot slotted waveguide array borrowed from Canada's Microwave Early Warning system to create an interferometer capable of resolving features of the solar surface even with clouds obscuring the sun. By orienting the length of this straight line array in an east-west direction, as Reber had done in Wheaton years earlier, the sun's microwave energy would be detected one slot at a time as it crossed overhead. As a result of this activity, Covington estimated that the solar atmosphere above the sunspots can reach the incredible temperature of 1.5-million K!

Much of the work that Covington performed was used during the International

Geophysical Year of 1957–1958 and for many years the 10.7-cm solar flux observations from Ottawa were reported by WWV, something familiar to amateurs of the day. It should be noted that 10.7 cm has since been officially recognized as the standard for solar flux measurements and the earliest such records can be attributed to the early work of Covington.

While physicists studied sources of celestial noise and their potential to affect phone communications, Bell Labs researchers also worked on more practical issues, such as improving the overall phone experience. One of the biggest problems was the way subscribers connected to the central phone office using slow rotary-type phones. To this end, Harry Nyquist developed a pushbutton phone for which he was awarded a patent in 1941 as shown in figure 3. Although not the phone that my classmates and I

experienced on that field trip so many years ago, its success within the phone company no doubt spurred the development of the more familiar consumer touch-tone phones that followed.

As the phone system grew, so did the complexity of the relay system used to direct all those calls. It was another Bell scientist, Dr. Claude Shannon, who would come to solve this problem. Having already developed Boolean algebra, a kind of math that allows binary systems to be reduced to their simplest form, and recognizing that relays are a form of binary system, Shannon used his Boolean algebra to significantly reduce the complexity and number of the relays then employed.

In 1948, Shannon would further apply his skills in mathematics to extend some of Nyquist's earlier work on telegraphic transmissions. Shannon's publication⁶ of

June 3, 1941.

H. NYQUIST

2,244,500

TELEPHONE SYSTEM

Filed Sept. 30, 1938

8 Sheets—Sheet 6

FIG. 8

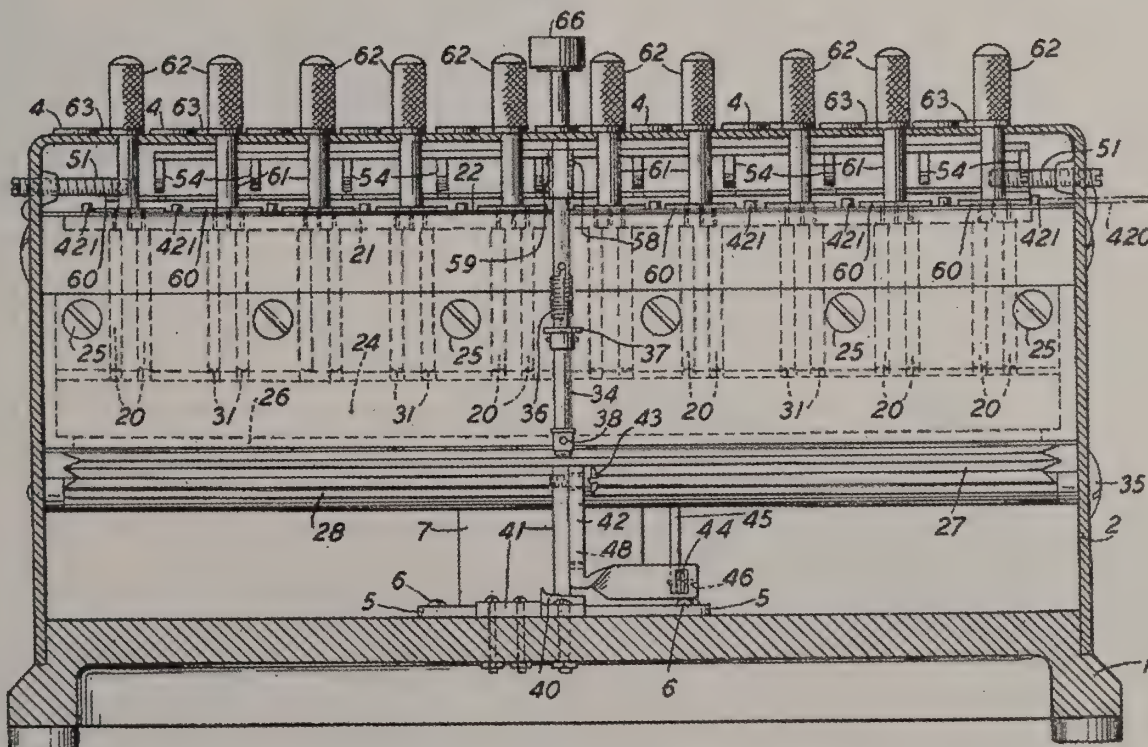


Figure 3. Harry Nyquist's patent for a push-button telephone. U.S. Patent Office.

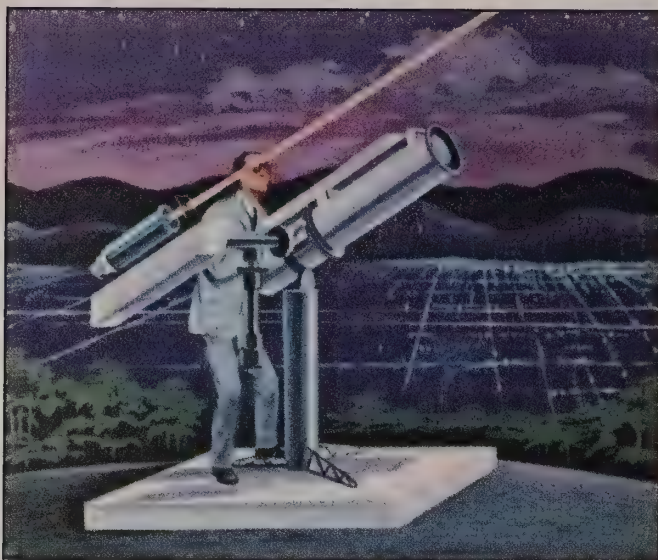


Figure 4. Early laser used for range-finding. From *American Space Digest*, published by Schick Safety Razor Company in 1963 with photo credit given to Hughes Aircraft Company.

"A Mathematical Theory of Communication" is considered the classic text on information theory, the foundation of digital communications, cell phones, digital music, picture phones, and satellite TV receivers. Without such techniques, our ability to communicate with deep-space probes millions of miles from Earth would be severely hampered, with the weak signals that are trying to be detected awash in noise. It is interesting to note that Nyquist's earlier work used the same coded characters that amateur radio operators were using at the time: Morse code! How interesting that the solutions to so many phone problems have found other applications in modern-day life.

In the late 1950s Charles Townes and Arthur Schawlow would develop the maser, the lowest noise microwave receiving apparatus of the day. One of the claims in the 1960 patent (2,929,922) assigned to Bell Labs is that a device of this type could also be used on optical wavelengths, thus pre-telling the future development of the laser.

In 1961, scientists were pondering various applications for the laser. Perhaps the first practical application can be attributed to Hughes Aircraft as shown in figure 4, which appeared in *American Space Digest* published by the Schick Safety Razor Company in 1963. This device, known as a Colidar, for Coherent Light Distance and Ranging, used a ruby laser to transmit a pulse of light to distant objects and an optical telescope to detect reflections. Although developed primarily for rangefinder applications, the patent issued to T. H. Maiman on November 14, 1967 (3,353,115) disclosed an instrument capable of tuning over a 500-GHz range for both optical radar as well as communications purposes. It is interesting to note that amateur radio operator George F. Smith, K6BYV, ex-W5GSD, played a role in developing the laser rangefinder in the early 1960s.

One problem using a laser for interstellar communications would have been light interference from the sun. Such "optical noise" would make it difficult if not impossible to discriminate the laser light amidst all this other light. To this end Charles Townes made the brilliant suggestion that a laser could still be used for interstellar communications, despite the proximity of any planet to its nearby sun, by taking advantage of the way

certain wavelengths of the sun are absorbed in its atmosphere. A spectrograph of the sun shows obvious dark lines that could be filled in using laser light of just the right wavelength. Also, by using short pulses of high power, the laser would be more readily visible to those searching for it.

In a letter⁷ written by Covington, VE5CC, to Reber, W9GFZ, on March 2, 1961 Covington remarks:

[I]t is interesting, I think, to realize that radio wave techniques grew out of the early optical experiments, and now with the introduction of the laser, the flow of ideas has returned once more to the investigations in the optical region. This has started completion of the circle, and perhaps we are now entering a new era in which there should be tremendous consolidation of scattered fields of experience.

By the early 1960s the techniques of Nyquist, Shannon, and others would find application in a new kind of radio platform, the satellite and space probe. In his book *Communications in Space* published by Holt, Rinehart and Winston in 1966,⁸ Leonard Jaffe, K3NVS, comments:

It is only because ground station technology was available in the areas of low noise microwave devices, large accurate parabolic antennas and high power wide bandwidth microwave amplifiers in the general time frame of the late 1950s and early 1960s that any practical consideration could be given to communications satellites. Most of this technology came from other applications areas—radio astronomy and radar; to name two. Ten years ago, the best ground station receiver sensitivity would have been inadequate by a factor of ten for a practical commercial communication satellite system. It is truly fortuitous that this ground station technology has come along at just the time that spacecraft power technology was reached a state requiring such a technology.

In Part 4 of this series we'll examine the role of the amateur radio enthusiast as he ventures into space using satellites and space probes.

As long as man has walked this planet he has witnessed the sun rising steadily in the east and setting in the west. Each new dawn has brought the promise of a new day. When man first saw the sun rise in a different light, using radio waves, he became witness to a new dawn, bringing hope not just for a new day, but for his further understanding of the Cosmos.

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Rare Visual Tropo Duct Surprises the Microwavers

What started out this past November as a Thanksgiving Day turkey dinner on the beach for a group of amateur radio operators turned into six hours of looking inside a tropospheric duct! Here is how it happened.

By Gordon West,* WB6NOA

Every Thanksgiving a group of us southern California ham radio operators head to the beach to drop a turkey into boiling oil. Many times we bring along a radio and set up a small 3-element beam. However, this year, rather than operating, we were just going to soak up the sun and spot some faint indications of the common fall inversion layer.

A quick Doppler radar weather check before we headed to the sand clued us in on the last day of a persistent high-pressure system over the southland. There was not a cloud in the sky and the indicated sea surface winds were at nearly zero.

"What caught my eye was the Doppler radar return echoes of a phantom curtain of reflection about 10 miles off shore," commented Suzy West, N6GLF. "On the short drive down to the beach, I couldn't imagine how the weather service was getting such strong echoes," added Suz. Soon we were to better understand what the radar was showing. However, before we get started with our understanding, let's do a quick review of normal atmospheric dynamics.

Microwaves and light waves normally travel 1.1 times farther than the optical horizon. The formula used to calculate the distance of the radio horizon, in kilometers is $D = \sqrt{17h}$, where h is the height of the antenna above water. As ham operators, we know this as 4/3 radio horizon, traveling slightly farther than the visual horizon on a normal day. This day, however, would not be "normal"!

Our atmospheric dynamics exhibit a decrease in air pressure with altitude in an approximately logarithmic manner. The higher we go, the less air pressure there is. Air temperature also decreases with altitude, approximately 20° Fahrenheit for every mile of increasing altitude up to



Photo 1. Los Angeles Times newspaper photographer Wally Skali takes a candid picture of Janet Margelli, KL7MF, carving the Thanksgiving Day turkey while Suzy West, N6GLF, and Chip Margelli, K7JA, look on. (Photo courtesy of K7JA)

40,000 feet. The number of water molecules also decreases with altitude, resulting in atmospheric density decreasing with height above the surface of the Earth.

The bending of both visual and radio waves is called *refraction*. The refraction of "normal" air is slightly higher than unity, around 1.000345. We know the refractive index of air *increases* in the presence of a stationary high-pressure system; as the heavier air within the high begins to sink, it is called *subsidence*). It bottoms out just above land, lakes, or seawater and becomes compressed with the continuing influx of descending air. Squish air and it gets warmer. This thin, and sometimes as occurred on this day, thick stratified band of warmer air can create a mirage, our English word that comes from the French word *mirer*,

which means "to look at." When considering mirages, down at an airfield or highway blacktop, you might see blue shimmers, like water. What you are seeing is not water. Rather, it is the refraction from the blue sky above. This is called an *inferior* mirage, where you look *down* and see the image of something *above*.

Microwave operators usually work DX from the *superior* mirage, which is an inverted image *above* the image that is sometimes far beyond the horizon. A superior mirage is usually seen as an elevated band of trapped smoke or haze, with well-defined visual characteristics of the duct itself. Here in southern California, we rely on the every July *superior* tropospheric duct that allows our 2-meter and 70-cm signals to traverse from the mainland to Hawaii, and to hear Hawaii

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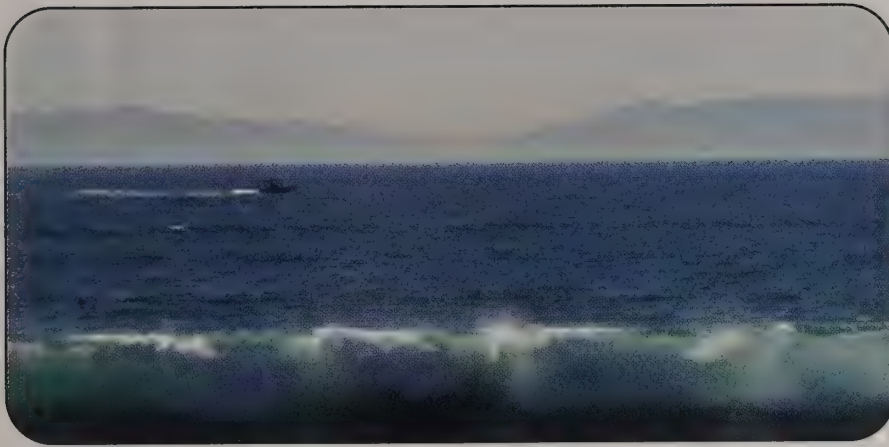


Photo 2. This is a well-developed phantom curtain which was caused by a temperature inversion that had developed about ten miles off the coast. Notice how it looks like a mountain range. As the day wore on this curtain would take on various shapes. The other photos in this article illustrate the changing shape of the curtain.
(Photo by K7JA)

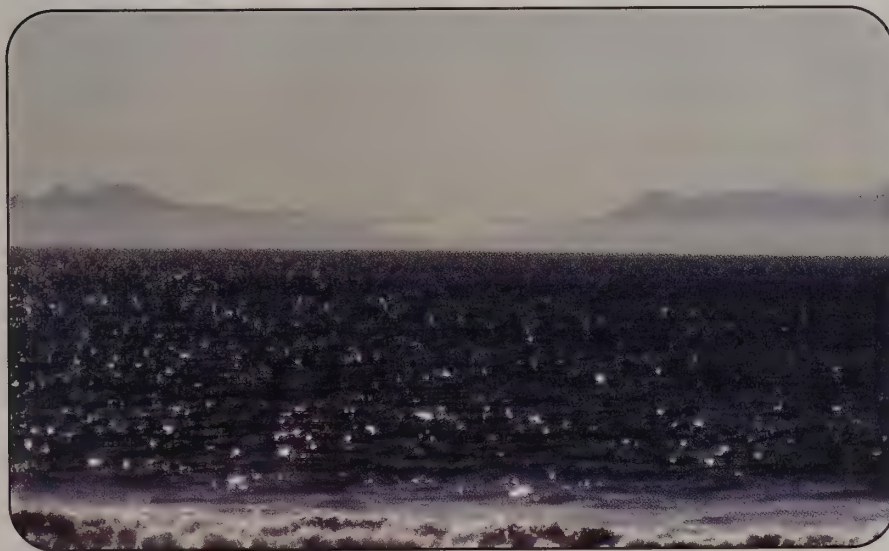


Photo 3. Notice how the curtain has changed shape from photo 2. The center has elongated and the "mountain ranges" on each side of the center hole have pushed up. (Photo by K7JA)



Photo 4. This photo was taken a bit north. Notice the difference in the consistency of the curtain to the right of the ship.
(Photo by K7JA)

VHF/UHF radio operators loud and clear at this end of the circuit. We need to be either below or within superior duct to take advantage of this type of long range tropo. Driving to a tall peak will sometimes put us *above* the duct, and we then hear absolutely nothing!

Most extraordinary, seldom occurring, and almost never photographed is the *Fata Morgana*, named after King Arthur's wicked half-sister, the sorceress Morgan le Fay, who, according to some legends, lived in a crystal palace under the waves and manifested her magical powers by creating mirages. On Thanksgiving Day we witnessed a *Fata Morgana*. A *Fata Morgana* is a unique occurrence of stratified (layers) of illusion changing in slow motion, exaggerating both height, width, and perceived closeness as the light moves through layers of different temperatures.

Our second clue (radar being the first clue) was a distant shoreline where a one-story house looked like a 20-story skyscraper. "Everything was elongated; houses looked like they were on stilts, and our customary headland looked like the cliffs of Dover," commented Chip Margelli, K7JA. As far as we could see, everything seemed to stretch upward.

"I especially liked the balancing act of a distant sailboat mast-to-mast with another upside down," added Janet Margelli, KL7MF. Even super tankers waiting to come into the ports of Los Angeles and Long Beach had normal dark-colored hulls, but their superstructures looked like Mt. Everest!

We estimated that the multiple layers were hugging the ocean and extending up about 500 to 1000 feet. Images within the mirage were distorted, but with a definite breakpoint above the mirage, turning back to a normal view.



Photo 5. The tropo gap is clearly visible in the center of the photo. (Photo by Walter Skali)



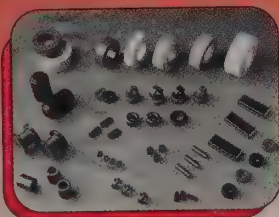
Photo 6. Gaps in tropo are clearly evident on either side of the center of this photo. An oil derrick is in the center. Furthermore, a tanker is visible on the right side. (Photo by Walter Skali)



Photo 7. This photo shows the now much closer tanker and the deterioration of the propagation wall going from the center of the photo to the right edge of the photo. (Photo by Walter Skali)

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As Thanksgiving Day and turkey were to come upon us, more magic began to appear on the horizon. Our local Catalina Island began to distort, and what appeared as a small isthmus near the west end of the island first evolved into a wide-open canal. Then, five minutes later, the image turned into towering cliffs on each side of the canal. Finally, five minutes later, it turned into a well-constructed bridge with a perfectly formed tunnel below! The extreme west end of the island, just off the bow of the anchored ship, became so distorted that it seemed to be larger than most other portions of the island.

It gets even better: A military-owned island, well offshore, called San Clemente Island, is seldom seen from the mainland at beach level. It is simply over the horizon. Not that day! At first, a band of black "smoke?" appeared to rise from the general direction of this other island and continued to build and build until suddenly the most majestic, detailed radio tower popped into view, shimmering in the sunlight. The tower reached taller and taller, and almost instantly developed a massive capacity hat on top. Then, in the blink of an eye, the whole island disappeared and became muddled in the brown distortion off in the distance.

The local newspaper photographer (who just happened to be there) was intent on capturing the sun's fleeting moment of "green flash" exactly as it dipped below the horizon, usually seen only in the tropics. He was in for a great surprise! He switched over to his longer lens to capture as many of these rare tropo shots as possible.

As the sun slowly sank, it grew horns, flattened out, turned square, broke into pieces, momentarily dipped and resurfaced, and then did a swan dive into the ocean with a plasma *blue* flash! All of this activity occurred too quickly to capture on film.

What does all this have to do with VHF/UHF/microwave DXing? Plenty:

1. Look for improved DX conditions within the stationary high.
2. Look at weather-service radar images on the computer.
3. Look for an elevated tropo haze formation hanging on the horizon.
4. Position yourself for extended long-range tropo contacts, listening for propagation beacons.
5. Visually scan a flat horizon and look for unusual images

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Dr. Ernest K. Smith, Jr. (1922–2009)

A Reflection on his Impact on Propagation Studies

We amateur radio operators who take advantage of sporadic-E propagation owe a lot to Dr. Ernest K. Smith, Jr., ex-N6HQQ, for all of the research he contributed to analysis of this mode. In this article WB2AMU eulogizes Smith by briefly summarizing his massive amount of contributions to propagation research.

By Ken Neubeck,* WB2AMU

Sad news came to the scientific community in October 2009 when it was learned that Dr. Ernest K. Smith had passed away at the age of 87. Dr. Smith was instrumental in the area of characterizing the sporadic-E phenomenon, a major propagation mode that is experienced by those who frequent the VHF bands such as 6 and 2 meters, among others on the ham bands. In addition, Dr. Smith was a radio ham for a number of years, holding the callsign N6HQQ until it expired early in 2009.

Dr. Smith's major achievement towards the better understanding the sporadic-E phenomenon was that he was instrumental in the reduction of the vast amount of hourly ionosonde data that was collected from around the world from different station locations. The data was used to come up with worldwide sporadic-E occurrence maps that were presented in the late 1950s in his two major works: *Worldwide Occurrences of Sporadic-E* (his first major work and his thesis, 1957) and *Ionospheric Sporadic-E* (1962), which he co-authored with Dr. Matsushita.

Dr. Smith was born in Peking, China in 1922 to Professor Ernest K. Smith and Grace Goodrich Smith. He left China in 1940 to go to America to attend Swarthmore College and then he completed his PhD at Cornell University. His career spanned several positions which he held for different government organizations, including the National Bureau of Standards, NOAA, the Jet Propulsion Lab,

and as an adjunct faculty member at Colorado University.

Dr. Smith initially got involved in the research of sporadic-E in 1949 while he was attending Cornell University for his Masters degree. He was presented with the problem of proving whether sporadic-E propagation was the cause of television interference caused by reception of distant stations. As Dr. Smith stated, "This was when I felt I was in the right place at the right time with the right background." From this point, he wrote papers that discussed sporadic-E data based on some amateur radio data and TV DX reception reports. Dr. Smith may have been the first scientist to conclusively demonstrate that the midpoint of a TV DX reception path fell near an ionosonde station where the ionograms showed strong indication of sporadic-E. He also found that the more data that was accumulated on sporadic-E the more consistent the statistics became, thus allowing for the construction of worldwide sporadic-E occurrence maps.

The importance of Dr. Smith's work in the area of sporadic-E cannot be understated, particularly in the early days of categorizing the behavior of this phenomenon. The collection of hourly ionosonde data from each station and then combining it with other ionosonde stations to be able to construct probability maps for the different seasons was a major accomplishment because of the amount of work that was involved. This was all done by hand calculations and manual labor during the 1950s before the age of computers!

Dr. Smith's main strength, in my opinion, was the fact that he developed an intuitive feel for the data that resulted in the



Dr. Ernest K. Smith (ex-N6HQQ).
(Photo by Boulder Torch Club)

specific construction of these maps (see figure 1 for an example). First of all, he was able to define the different zones of Earth related to sporadic-E behavior: the north and south aurora zones, the north and south temperate zones, and the equatorial zones. Second, he was able to determine the division of the data for the Northern and South Hemispheres into three seasonal categories: the summer season, the winter season, and the combined fall/spring equinox period. It was through Dr. Smith's research that some form of statistical probability could be established with regard to the summer season, the winter season, and the equinoxes.

In addition, through the collection of this massive data, it became apparent to him and others working with him that Japan and parts of Asia had the highest incidence of summertime sporadic-E with the highest measured critical frequency and measured maximum usable frequency (MUF) on a yearly basis. Conversely,

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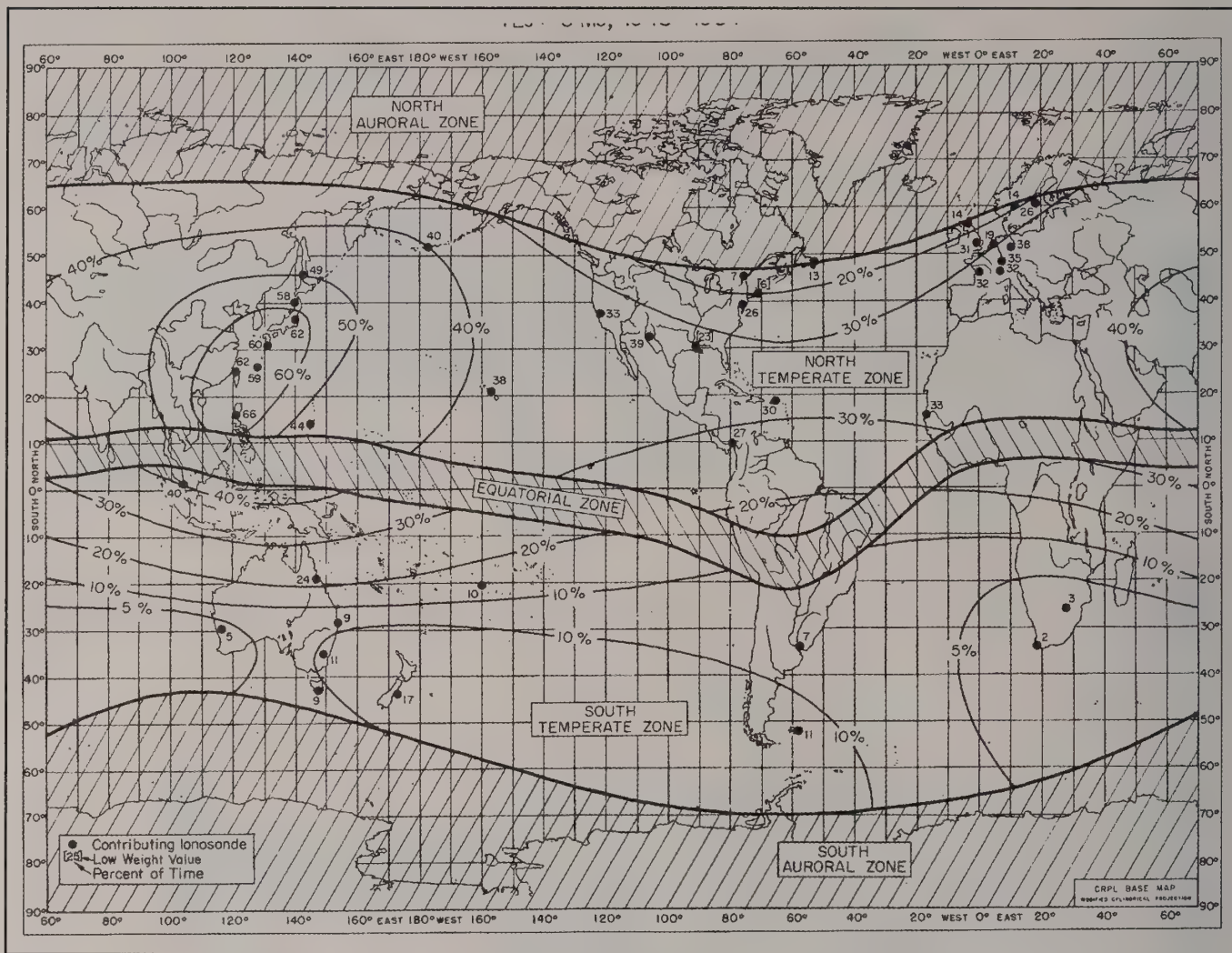


Figure 1. Early worldwide sporadic-E map showing the major zones on Earth during the summer months for the years 1948 to 1952.

the lowest incidence of sporadic-E was observed to be in the South Africa area.

Dr. Smith's initial set of sporadic-E maps was published in the National Bureau of Standards (NBS) circular number 582, *Worldwide Occurrences of Sporadic-E*, and then with the additional ionosonde station data collected during the International Geophysical Year (IGY), he presented a more refined set of maps in his co-authored book *Ionospheric Sporadic-E*.

Dr. Smith cited in his papers the importance of early 6-meter studies involving amateur radio, specifically the one that took place from 1949 through 1951 and included about 350 North American radio amateurs. He also noted that in one study conducted by the Air Force in 1965, the approximate size of a sporadic-E formation could be determined by the plotting of the paths of amateur radio reception reports involving 50-MHz contacts.

For Dr. Smith, much of the research on sporadic-E ended by 1970 because of changing government interest and funding. However, he continued his efforts through different working groups.

I had some contact with Dr. Smith in the course of researching my articles on sporadic-E, both by phone and by mail during the latter part of the 1990s. I found him to be most helpful and soft spoken, along with being generous with providing information for my articles. In one of his earliest responses to a question, he sent me a copy of *Worldwide Occurrences of Sporadic-E*. He seemed very glad that there was current interest in the sporadic-E phenomenon by VHF hams such as myself.

In his later years, Dr. Smith continued pursuing his interest in the high incidence of sporadic-E in Japan with a paper that he co-wrote with Professor Kyoshi Igarashi in 1997: "VHF Sporadic-E – A

Significant Factor for EMI." This paper focused, in particular, on the high incidence of sporadic-E in Japan, where data of critical frequencies exceeding 15 MHz (which is roughly equivalent to a MUF of 80 MHz) from four ionosonde stations in Japan were studied during the years from 1957 through 1986. In addition, Dr. Smith wrote the propagation column for the *IEEE Antenna and Propagation* journal, which was published monthly.

Several VHF hams were able to meet Dr. Smith when he made a presentation at the Central States VHF Conference in 1999 in Kansas City, Missouri, where he reviewed his observations and personal reflections on sporadic-E from the early years. His presentation is documented in the *Proceedings* for that conference and has been published by the ARRL. It is definitely worth reading. The VHF community owes a lot to the work that was performed by Dr. Ernest K. Smith.

Beginning Experiments on the VHF Amateur Bands

In this issue of *CQ VHF* we welcome Rick Campbell, KK7B, one of the most prolific writers of amateur radio related technical articles and designers of amateur radio projects. Here he gives us a peptalk of sorts concerning our mandate to build, modify, and experiment. He then describes using a 6-meter to 40-meter converter to operate QRP CW on the 6-meter band.

By Rick Campbell,* KK7B

I have been experimenting on VHF since I discovered as a young teen that I could spread coil turns in an FM transistor radio and tune in signals above the FM broadcast band. In those days, the VHF ham bands were populated by experimenters. Everyone's station had some homebrew gear, and my beginner's questions were welcomed by gentlemen who were willing to put down the soldering iron long enough to help me get a station on the air. Those early days led me to degrees in physics and electrical engineering and a long and varied career in basic research, university teaching, and designing the microwave radios inside cell phones.

Over the years the VHF bands evolved from the playground of experimenters to something else. Homebrew gear is now rare, and gentlemen with soldering irons who understand the inner workings of radio technology are not as visible. However, they are still around, often retired from careers in electronics and radio. I'm not ready to retire yet, but I'd like to re-create some of those early VHF games that I played and observed in my early years. There is still no better place to explore the magic of radio than the VHF bands—with small antennas, low power, slow CW, easy modulators, simple test equipment, and basic receivers. This series of articles will introduce basic experiments and experimental gear for the VHF amateur. We'll start with a low-power signal source, and then progress through receivers, modulators, more capable antennas and stations, portable operation, etc.

Our amateur radio license is more than permission to transmit; it is also a license to build, modify, and experiment with transmitters, antennas, and signals. For a

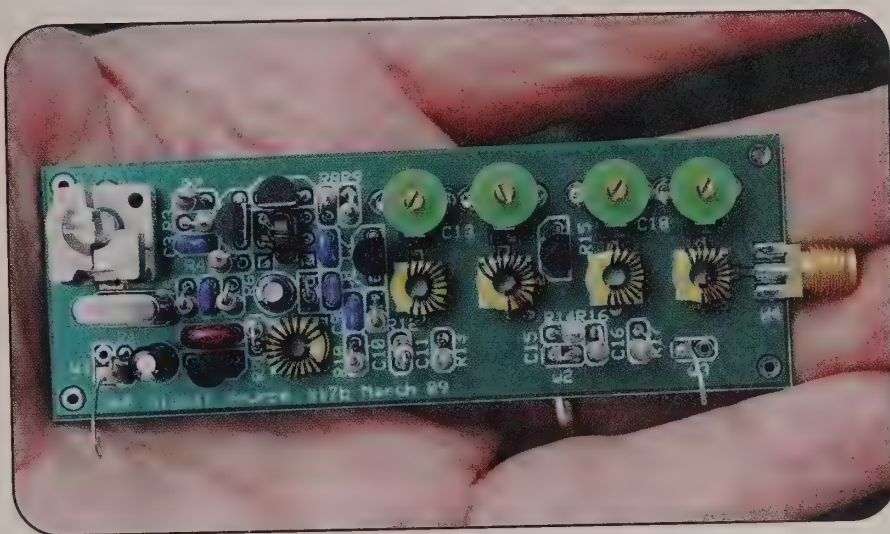


Photo A. A 10-milliwatt CW source available as a kit from Kanga US.

large and very interesting group of amateurs, experiments are the focus of amateur radio and often result in spin-off technology for other services. Amateur experiments are different from simply operating a radio to make contacts, and require different equipment as well. Fortunately, we can get started exploring radio science at very little expense. The most basic radio experiment is generating and radiating a signal, picking it up on an antenna, and listening to it. We need a receiver, which you may already have, and a low-power VHF signal source. Low power is essential for several reasons: You want to pick up the signal across the room without overloading your receiver; you want to connect experimental modulators and amplifiers to the output; and you don't want to interfere with other amateurs while experimenting.

CW is a good choice for many reasons, but the obvious one is that CW provides a constant frequency and amplitude to

make repeatable measurements. Your signal source isn't just a low-power transmitter; it's a signal generator for your bench as well. You don't need to learn to communicate using Morse code to operate a CW signal generator. However, if you are going to radiate it on the air connected to an antenna, you need to be able to send your own amateur callsign to identify the transmissions. You don't even need a key; a push-button switch will do, and you can write the dots and dashes on a piece of paper until you have your own callsign memorized. Fast CW is for HF; VHF experimenters use slow CW. It is more effective when signals are weak, and we are more interested in making one difficult contact than racking up a large number of contest points per hour.

Photo A is a 10-milliwatt CW source available as a kit from Kanga US for \$27. It has a few chip components and some toroids to wind, so if you haven't done any construction you will need some

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guidance. One of the most interesting experiments is to find out how far away you can hear a 10-milliwatt 50.100-MHz signal, and for that goal you will need a friend. Find one who has a magnifying glass and a fine-tip soldering iron. The complete schematic and other construction details are on the Kanga website: <<http://www.kangaus.com/>>.

The Signal Source Circuit

The CW source has three sections: a crystal oscillator, frequency multiplier, and narrow-band amplifier. The crystal oscillator generates a signal at one-third the desired output frequency. By generating the frequency at HF, we can use a stable fundamental-mode crystal oscillator with a variable capacitor in series with the crystal to vary the frequency by a few kHz above and below the frequency marked on the crystal.

We then multiply the frequency by three in a single-transistor circuit. There are many clever frequency-multiplier circuits, but few work as well as this old standard, and very few are simpler or more reliable. Following the frequency multiplier is an amplifier with a double-tuned circuit on its input and output. When tuned to the desired third harmonic of the crystal oscillator, all the other close-in outputs from the frequency multiplier are more than 70 dB down. The harmonic levels at 100 MHz and 150 MHz meet FCC regulations for direct connection to an antenna. This is a very clean signal source.

It is not necessary to understand all the subtle circuit details at this time. The sky was blue for a long time before Rayleigh worked out the electromagnetic theory to explain why. A good experimenter gets things working first and makes some measurements before trying to understand what it all means. That is the first rule: Get it working and then ask questions. Children and college students like to ask a lot of questions first to delay starting an assigned task. Authors of technical articles receive many questions via e-mail. The good ones almost always come from folks who have started a project and encountered a puzzling result.

Bill Kelsey has set up a Yahoo group, VHFkits (see <<http://groups.yahoo.com/group/vhfkits/>>), where we can quickly answer any questions that arise. As you

start to build and measure VHF hardware, the first thing that improves is the quality of your questions.

The VHF signal source in photo A may be connected to a 50-ohm resistor and homemade Morse code key as shown in figure 1, or connected to a simple dipole antenna as shown in figure 2. I find the combination of low power and homemade Morse code keys is the easiest way to get folks over any fear of putting a signal on the air. With the 51-ohm resistor connected, anyone can try the key. With an antenna, you need to send your call-sign every 10 minutes. Use the formula for the length of a half-wave dipole from your Technician License exam to figure out how long the antenna should be.

Now that the source is on the air (use the resistor first), tune a receiver to

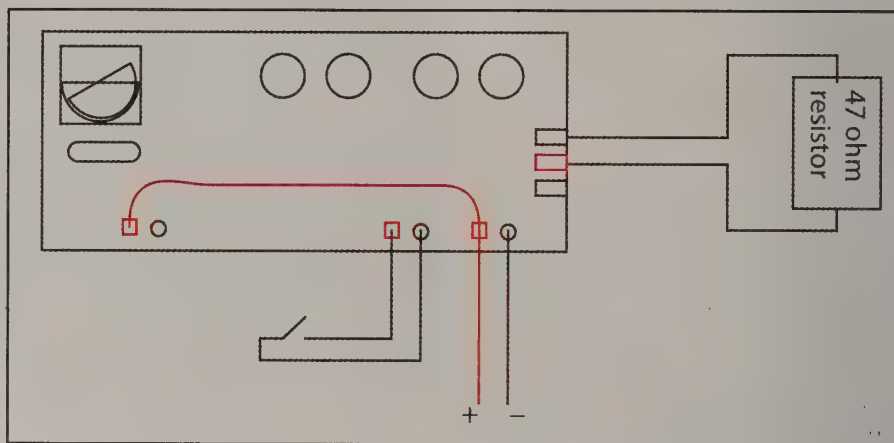


Figure 1. The VHF signal source in photo A may be connected to a 50-ohm resistor and homemade Morse code key.

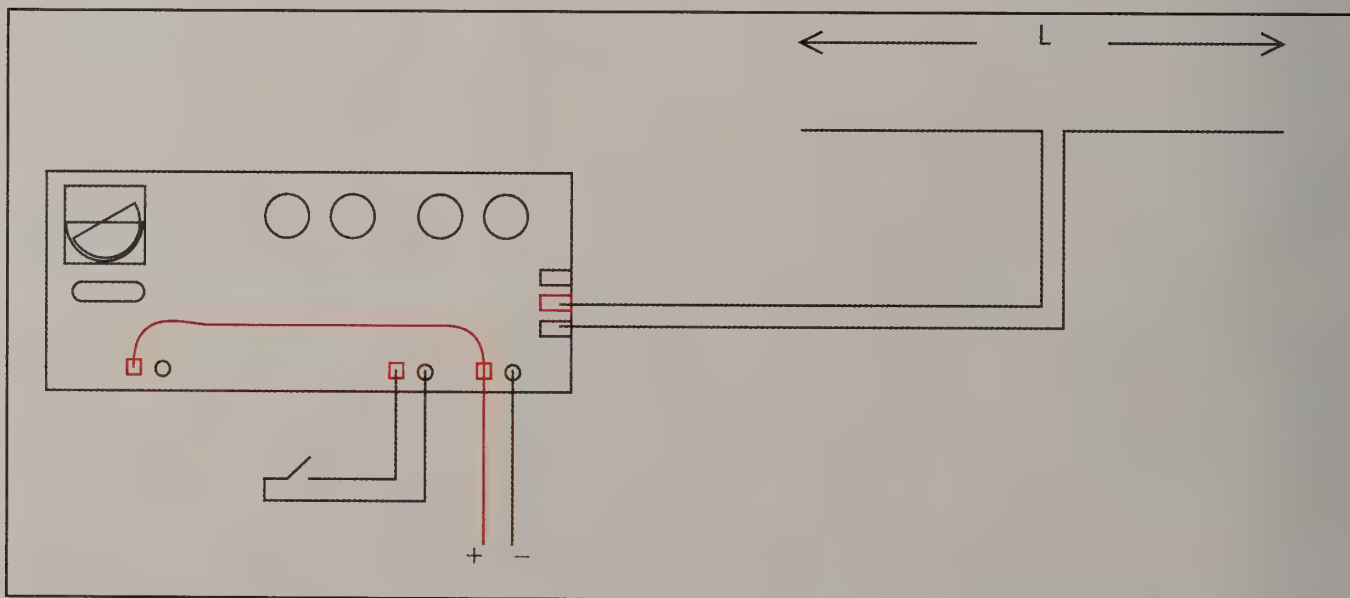


Figure 2. The VHF signal source in photo A may also be connected to a simple dipole antenna as shown here.

50.100 MHz and press the key. I recommend starting with the VXO capacitor plates fully meshed, which should put the signal below 50.100 MHz, in the CW portion of the 6-meter band. You can tune in the signal on an HF/6-meter transceiver, any of the new radios that cover most of the bands between 160 meters and 70 cm, a wide-range receiver, or a hand-held that will tune 6 meters. I keep a little ICOM Q7a on the bench for a check of my VHF signals.

Even with a resistor across the output, you will be able to pick up the signal

across a room. The simple power detector circuit in figure 3 may be connected to the output to allow you to tune the four variable capacitors in the narrow-band amplifier. More examples of simple power detectors are in *Experimental Methods in RF Design*, available from ARRL. The plastic on top of the trimmer capacitors is transparent enough that you can tell if the plates in the capacitor are fully meshed. Start with the capacitors at half mesh, and you will be close. It is possible to tune the output filter to 33.4 MHz (16.7×2) or 66.8 MHz (16.7

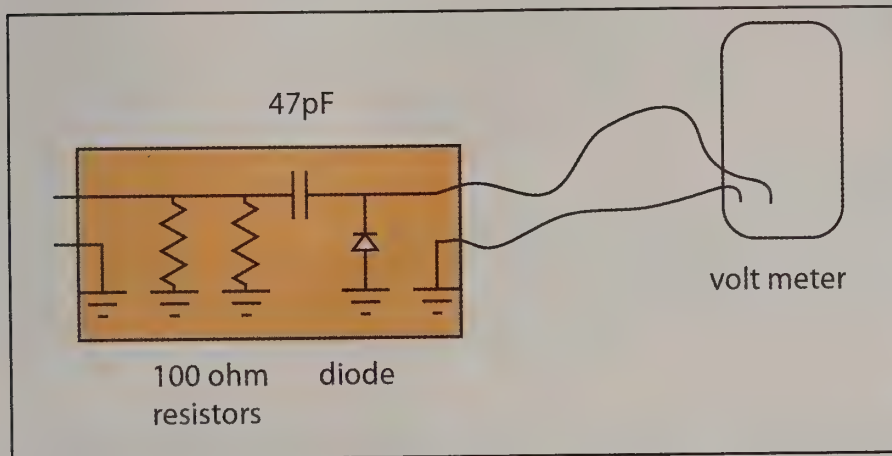


Figure 3. Even with a resistor across the output, you will be able to pick up the signal across a room. This simple power detector circuit may be connected to the output to allow you to tune the four variable capacitors in the narrow-band amplifier.

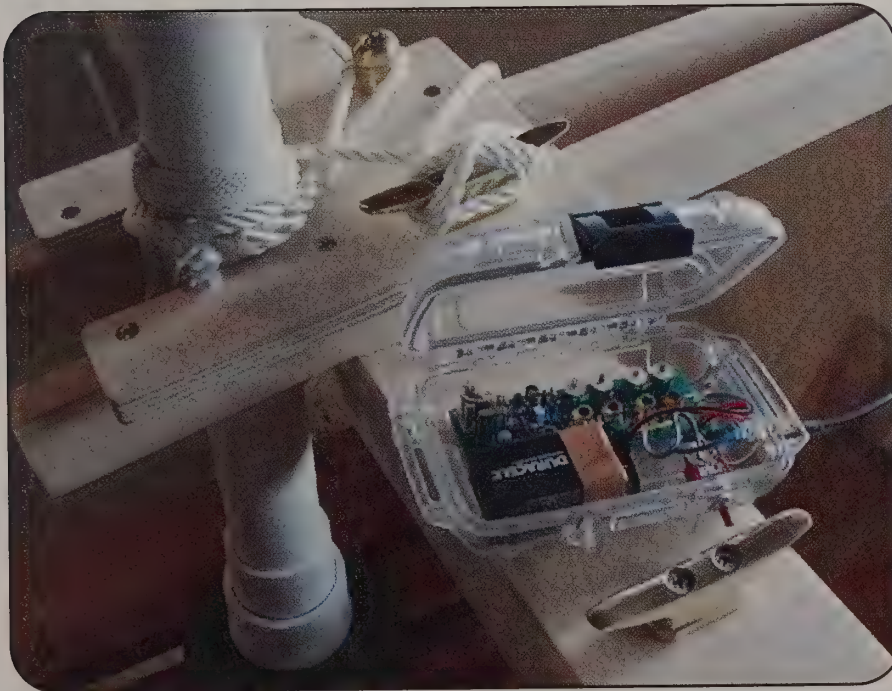


Photo B. An ultra-portable 6-meter CW rig that I put together to take across the lake in a small sailboat.

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Photo C. If you want to get a head start on a very capable 6-meter receiver, check out the Rcx1 6- to 40-meter receive converter on the Kanga US website. Shown here is that little receive converter taped to the top of a little 40-meter SSB-CW receiver, a microR2 from Kanga.

× 4). You can be sure you are tuned to the right output by starting with the capacitor plates half meshed, and listening on the receiver to make sure the signal gets louder when you have the signal source tuned for maximum. If you have an oscilloscope, you can use it instead of the diode detector by connecting the high-impedance scope probe across the 51-ohm resistor. This way you can see the output waveform and use the scope time-

base to confirm that you are tuned to 50.1 MHz. Most experimenters eventually own an oscilloscope, and once you do it is hard to live without one.

Low-Power Experiments

Ten milliwatts on 6 meters is not a lot of power, but with the right antenna and a good receiver the signal can be heard on any path where you can see the other station, as well as shorter paths with obstructions in the way. If you have a friend within a mile or two who has an outside antenna and a rig that will copy CW, hang the dipole outside, send your call sign with the key, and see if he can hear you. Six-meter dipole antennas are easy to set up and take down, and can easily be disguised to look like something other than a radio antenna. The center of the dipole is more important than the ends, so if the available space is too short, let the ends droop.

Suppose you hang your 6-meter dipole from the apartment balcony, and your friend a half mile away can hear you nicely on his FT-817. You'd like to make a two-way contact, but all you have is the CW signal source and a handie-talkie that covers 6 meters. Turn your HT to AM receive mode and have your friend transmit some CW. Leave the signal source on, but with the key up. Move your HT with its rubber-duck antenna around near the signal source, and you might hear some Morse code. There will be a place that gives you the best CW signal. How is that possible? The HT has an AM receiver! Actually, this is the oldest way to receive continuous-wave Morse code. You tune in your AM receiver, and somewhere nearby, a weak CW oscillator at almost the same frequency as the signal you want to receive. The two signals beat together inside the receiver, and the difference frequency goes to the audio amplifier and out the speaker. In the old days, the nearby CW oscillator was called a "local oscillator." In fact, it still is—but now it is usually inside the receiver. The math is a bit more complex, but it can also work with an FM-only HT. Try it!

At this point clever experimenters will start sketching all sorts of ultra-portable 6-meter CW rigs. Photo B shows one that I put together to take across the lake in a small, wet sailboat. The 10-milliwatt CW source is in the waterproof container with a 9-volt battery. The signal from the other station is received on the IC-Q7a that rides in another waterproof box with a dipole and log book. I use the rubber duck for receiving and the good antenna (hauled up the sailboat mast) for transmitting, because the other station has a good receiver and much more transmit power.

The next steps involve more power and a better receiver—and a few other decisions. One watt of CW will work the world with a good antenna and band opening, but that will require a better receiver and some good CW operating skills. Perhaps you'd like to experiment with voice modes. AM is easy, but that will require a different crystal for 50.400 MHz. DSB and SSB are also fairly easy to generate, and we'll play with those as well.

For anyone who wants to get a head start on a very capable 6-meter receiver, check out the Rcx1 6- to 40-meter receive converter on the Kanga US website. We'll describe that in more detail next time, but meanwhile, photo C shows that little receive converter taped to the top of a little 40-meter SSB-CW receiver, a microR2 from Kanga. Any 40-meter SSB receiver will work, but some of them are much cooler than others.

Until next time . . .

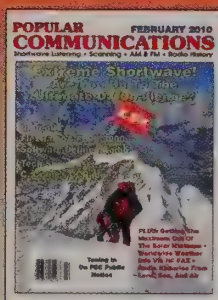
73 de Rick, KK7B

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Digital Wattmeter Element for the Bird Model 43 Wattmeter

Long a mainstay in amateur radio shacks, the Bird Model 43 Wattmeter has one very important weakness—the analog meter. Here WA8SME describes how he replaced the rather pricey meter with a digital meter element he designed and built for his Model 43.

By Mark Spencer,* WA8SME

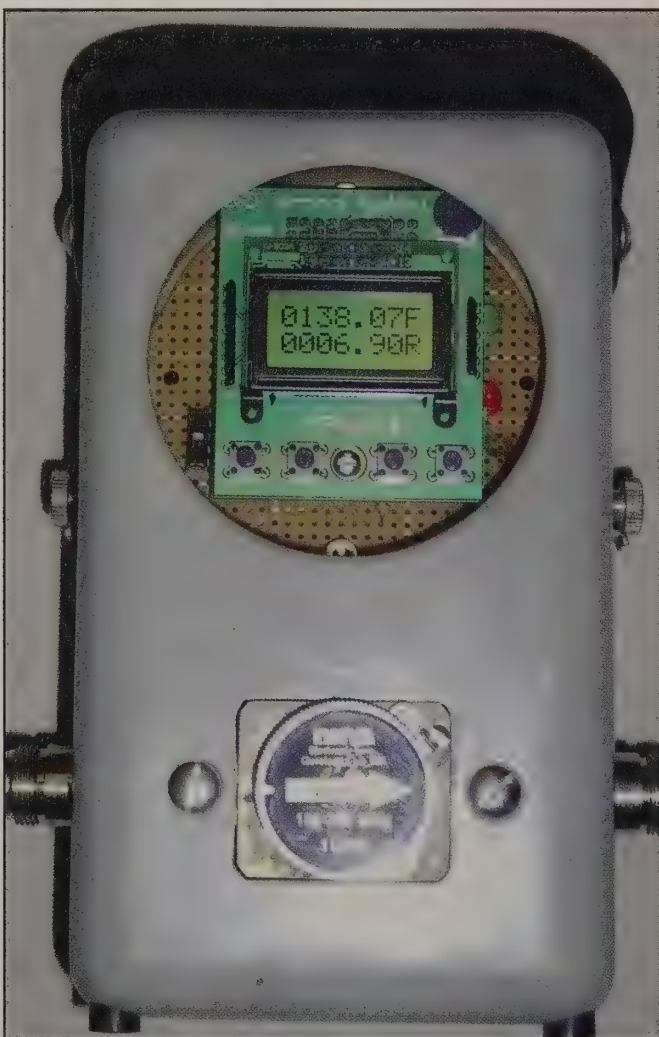
My Bird Wattmeter is tied for second place as my most important and most used piece of test equipment. First place, hands down, goes to my voltmeter; my MFJ Antenna Analyzer shares the second place slot with the wattmeter; and my oscilloscope comes in third.

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774 Eastside Rd., Coleville, CA 96107
e-mail: <mspencer@hughes.net>*

The wattmeter has been an invaluable asset in installing and maintaining my satellite ground station antenna system. It is rugged, reliable, and fairly easy to use except that you have to enter the forward and reflected watt readings into a formula to calculate the VSWR. This really isn't that big a deal and keeps the dust off the gray matter. However, I did have a friend who dropped his wattmeter and broke the analog meter element. That got me thinking: How much would it cost if my meter experienced the same fate? Wow . . . around 150 bucks to replace the analog meter movement!

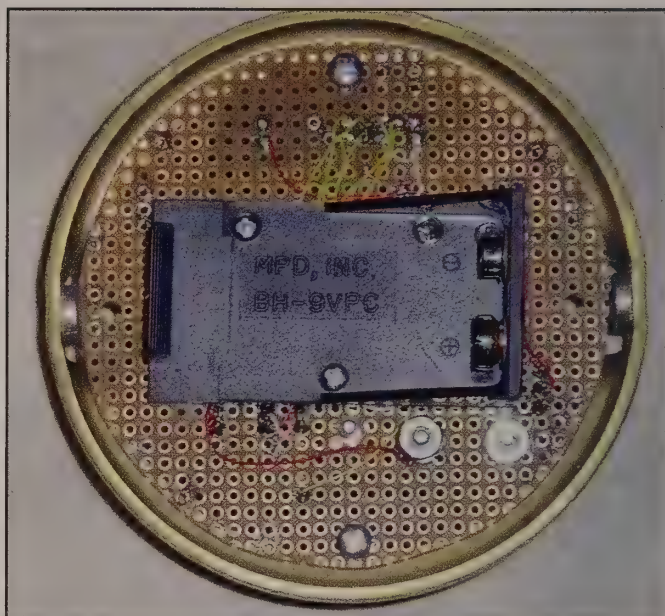
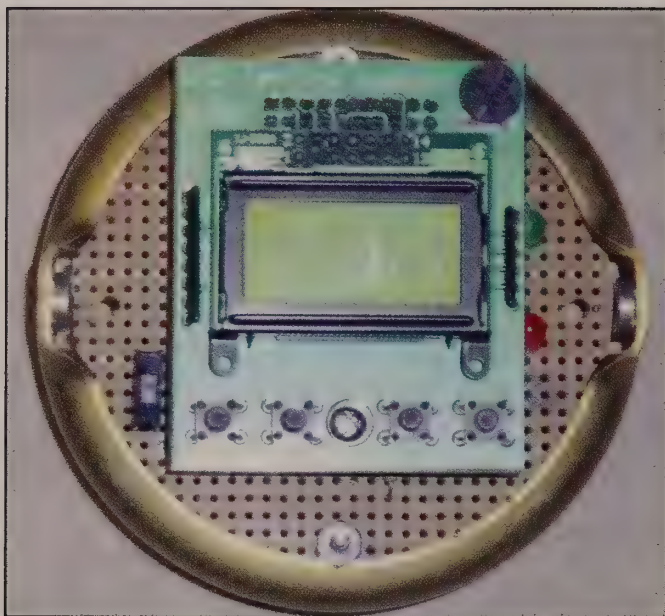
That thought was the catalyst for the project detailed here, a replacement or add-on digital meter element that could more affordably bring a broken Bird Wattmeter back to life and do some of the SWR and power-loss calculations for me. The digital wattmeter element is designed to actually replace the analog meter element inside the Bird or be mounted in an external enclosure to augment the standard Bird (figures 1 and 2).

The digital wattmeter element is based on a PIC®16F688 microcontroller and an inexpensive LCD display module. Refer to the circuit diagram of figure 3 for the following discussion of the circuit. The digital wattmeter element is powered by a 9-



Figures 1 & 2. The digital wattmeter element is designed to either replace the analog meter element inside the Bird Wattmeter (left) or be mounted in an external enclosure to augment the standard Bird (below).





Figures 4 & 5. The prototype of the digital wattmeter element mounted in the Bird analog meter mounting ring.

answer. The C-compiler allows the programmer to use the power of the higher level computer language C and then translates the C code into assembly and machine language code that is used by the PIC. Unfortunately, these hefty formulas require a lot of computer memory space to store and execute the code. I prefer to use PICs that have 2 kilobytes of memory (for cost reasons, and also most of my projects do not require a lot of memory), but in this case more memory was needed (approximately 6 kilobytes) and the PIC16F688 has this amount of memory (with a modest increase in cost of a buck or two).

The best way to go through the program logic is to describe how the digital meter element is used in operation. When power is first applied to the digital meter element, the PIC and the LCD are initialized, the previous scaling factors used are recalled from EEPROM, and the meter defaults to reading forward power. The green LED illuminates and the digital meter is ready to go.

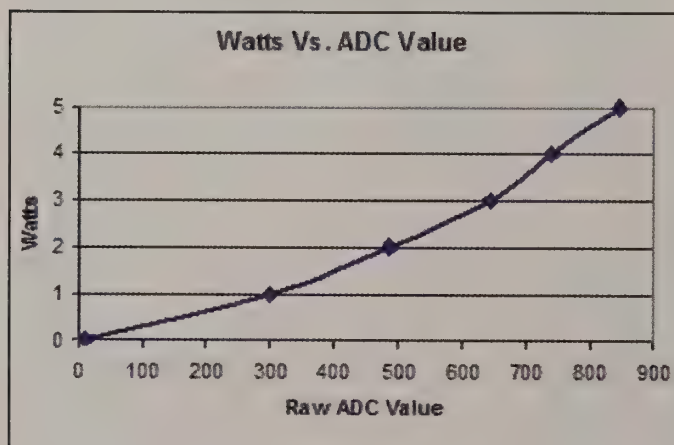


Figure 6. Graph that shows the relationship between the measured watts and the ADC values.

As illustrated in the figures, there are four pushbuttons that are part of the LCD unit (I'll label them buttons 1 through 4, from left to right, for this discussion). The two middle buttons (2 and 3) are programmed to select either reflected or forward power as the active wattage being measured. When first turned on, the display will have 0000.00 F (for zero watts forward) on the first line of the LCD, and an R (for reflected) on the second line. The green LED will also be illuminated as a visual indicator of forward power. There may be some random noise on the ADC that will give non-zero wattage indications when power is not applied to the Bird Wattmeter. When you press button 2, the digital meter element will switch over to measuring reflected power, the green LED will extinguish, the red LED will illuminate, the last forward watt reading will remain on the top line of the LCD, and the reflected power will be displayed on the second line of the LCD. To revert to measuring forward power, press button 3, the red LED goes out, the green LED comes on, the last reflected power read remains displayed on the second line of the LCD, and the current forward power is displayed on the top LCD line.

The Bird uses interchangeable slugs that are calibrated for frequency and power, and then the slug is rotated in its directional socket on the front of the Bird to measure forward or reflected power. The Bird analog meter has three scales that are applied during reading and/or calculations depending on the power of the slug in use: 0 to 100 for 10-, 100-, and 1000-watt slugs; 0 to 50 for 5-, 50-, and 500-watt slugs; and 0 to 25 for 25- and 250-watt slugs. The digital wattmeter element needs to be set to the appropriate scaling to display and make accurate calculations. The right-hand pushbutton (4) on the LCD unit is programmed to toggle through the various slug watt values when pressed by the user. When button 4 is pressed, the watt scale for both forward and reflected readings is displayed on the appropriate line of the LCD. Holding button 4 will step through the various scaling factors for the active channel (forward or reflected); release the button when the desired scaling factor is reached. This value is stored in EEPROM of the PIC



Figure 7. While applying power to the wattmeter, press button 1 to calculate the VSWR and power loss. The top line of the LCD will display the SWR and the second line will display the power loss in dB.

and is retrieved when the digital meter is subsequently powered-up. Press the appropriate button to select the other measurement channel to set its scaling factor. During my typical operating, I use the 100-watt slug to measure forward power and the 5-watt slug to measure reflected power, so these are the scaling factors that I use most frequently.

After you have the scaling factors set up, you're ready to take some SWR readings. Have the appropriate slugs on hand. I'll illustrate with the 100- and 5-watt slugs. Install the 100-watt slug and rotate it to the forward direction. Turn on the digital meter element. Apply power to the Bird Wattmeter and the forward power will be displayed. While the forward power is being displayed, press button 2 to switch the digital meter element over to reflected power (the forward power is now stored and displayed on the LCD). Turn off the transmitter RF. Swap out the slug to the 5-watt slug and rotate it in the reflected direction. Again apply transmitter power to the Bird Wattmeter and the reflected power will be displayed on the LCD. While apply-

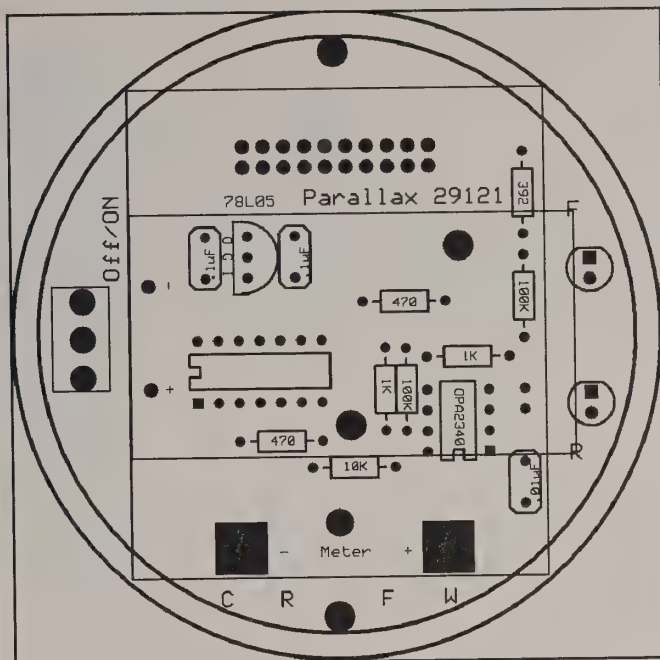


Figure 8. Prototype of the PCB the author plans to have manufactured for the project.

ing power to the wattmeter, press button 1 to calculate the VSWR and power loss. The top line of the LCD will display the SWR and the second line will display the power loss in dB (figure 7). When you release button 1, the digital meter element will revert back to measure reflected power.

Some of you may be concerned with the accuracy of the digital meter element, and this is a legitimate concern considering all the conversions of voltages to ADC values, converting integers to float values and back again, curve fitting, and all the calculations going on and the rounding errors that result. Using the PIC and doing the calculations with limited variable sizes does introduce some rounding errors, but frankly so does using your eyes to read an analog meter. I have found that the digital meter element is about as accurate as using the eyeball and calculator. You just have to recognize that even though the digital meter element will display numbers to two decimal places that does not necessarily mean that the displayed results are accurate to the hundredth.

Summary

This little project has turned out to be pretty useful. I plan to get a PCB manufactured for the project to make it more professional looking and more rugged. Figure 8 illustrates what I have in mind. The final cost of the digital wattmeter element turns out to be a fraction of the cost of a replacement analog meter. The addition of the calculated VSWR and loss figures is a nice feature. I encourage you to consider duplicating this circuit to enhance your Bird Wattmeter, repair your Bird, or put into service that good deal on a broken Bird you got at the last hamfest. I will conclude with a bad pun intended, "A Bird in the hand..." Well, you know what I mean.

If you would like more information about this project, feel free to contact me at <m Spencer@hughes.net>.

Digital Television: The New Ham Frontier

Among the many talks presented at the 2009 ARRL/TAPR Digital Communication Conference was one by WA8RMC on digital television. This article is based on his talk and the paper that was published in the conference Proceedings.

By Art Towslee,* WA8RMC

United States broadcast digital television started in the early 1990s and the official transition to all digital took place in June 2009. Amateur digital television started somewhere around 2000 mainly in Europe with on-air signals not appearing until around 2002 when some digital-board sets became available. Since then amateur digital TV repeaters in Europe have been increasing in popularity, but sadly the interest seems to be lacking in the USA.

In January 2004 the ATCO Group (Amateur Television in Central Ohio) in Columbus, Ohio installed a DVB-S digital output to its repeater, which has been in service 24/7 since then.

As of July 2009, the ATCO Group is still the only one in the USA with a digital ATV (Amateur Television) repeater output.

The ATCO repeater digital output uses DVB-S modulation which we believe is the best choice for amateur television. The following discussion details more fully why we feel it is best, along with operational experiences to back it up. I know of no other group, in the USA or Europe, that justifies it with "in service" data. Therefore, we are able to back up our statements with results and not just theoretical details.

DATV Advantages over Analog

Picture quality is near perfect. Strong and weak signals are all "P5," which is a snow-free signal. Historically, analog ama-

*e-mail: <towslee1@ee.net>

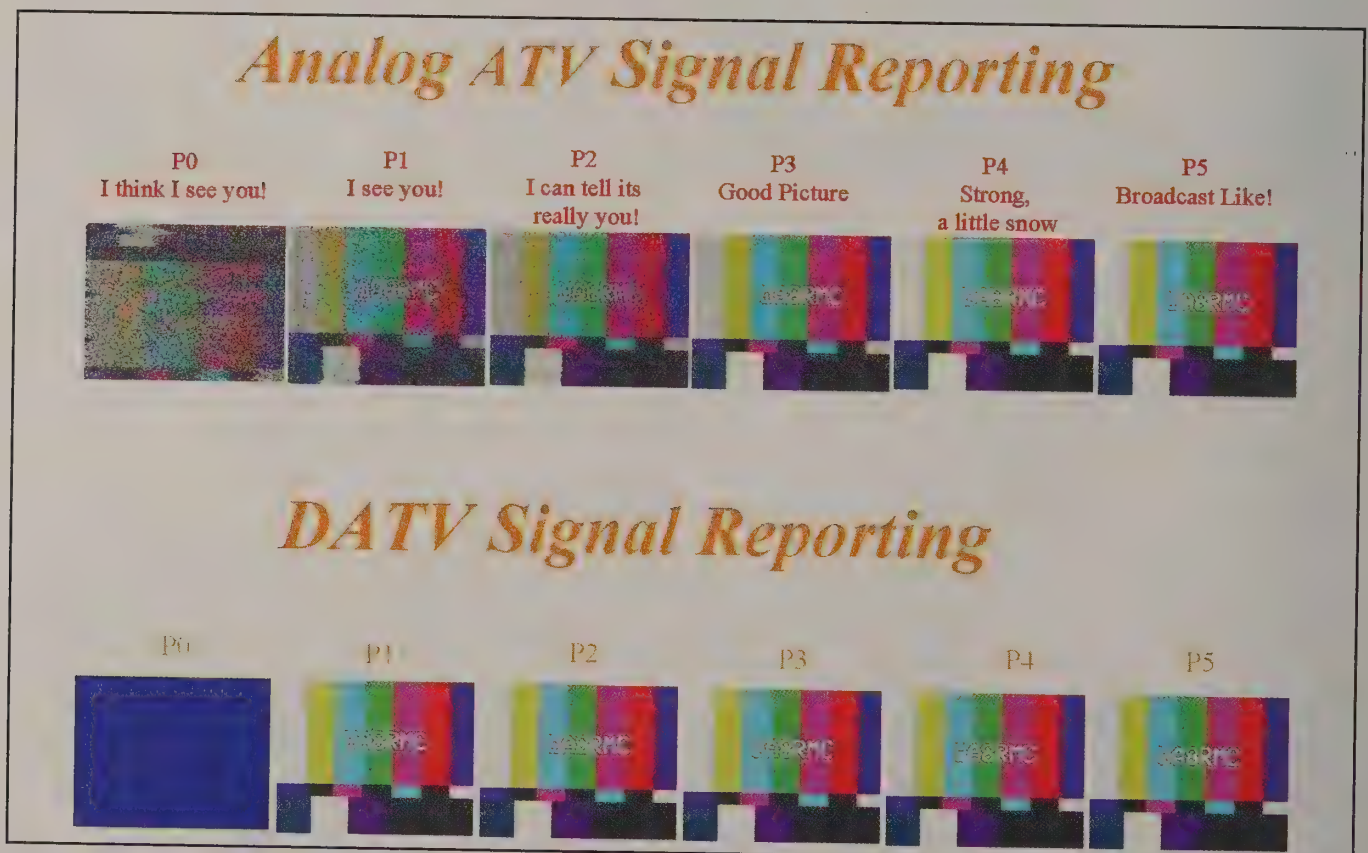


Figure 1. Comparison of signal reporting between analog and digital signals. Notice that in digital one either sees a blue screen (P0) or a clear signal (P1-P5).

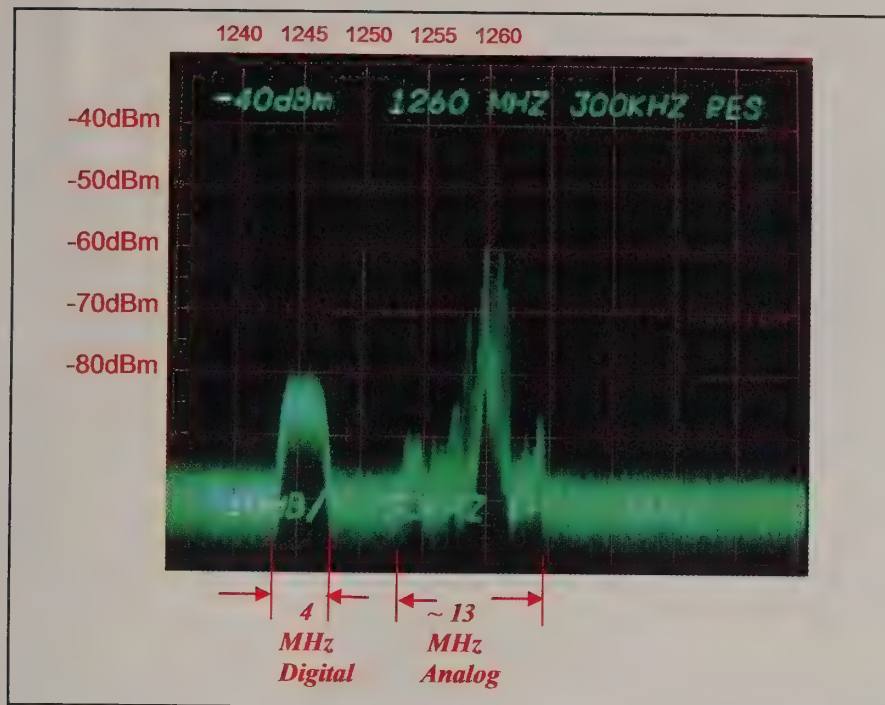


Figure 2. Bandwidth of digital versus analog signal.

teur television signal strengths are indicated by the "P" unit system where P0 is a barely detectable signal and P5 is snow-free. The strengths increase in 6-dB steps from P0 to P5, so P5 is $6 \times 5 = 30$ dB stronger than P0. That's for analog. A digital signal that produces a blank receiver screen with a P0 signal will produce a P5, or snow-free, picture if it's only 1–2 dB stronger. Therefore, in the analog world, if the signal strength was 1–2 dB greater than P0, the viewer would see a barely discernable picture; in the digital world the viewer would see a snow-free picture. (See figure 1.)

Noise and multipath cancellation possible. The DVB-S QPSK modulation scheme uses FEC (forward error correction) to cancel the effects of atmospheric/manmade noise and multipath (ghosting). The noise is handled by the Viterbi software algorithm and multipath is handled by the Reed-Solomon software algorithm, which are highly complex effective ways of handling the data streams but beyond the scope of this discussion. Since the DVB-S modulation scheme is intended mainly for satellite-to-ground communication, multipath is minimal, so correction requirements are also minimal and simple but adequate for ATV applications.

Noise reduction. As mentioned above, the Viterbi coding algorithm reduces noise due to atmospheric and manmade influences, but is minimal. Here also,

hams are willing to tolerate some noise disturbances in the picture. However, it doesn't show up as the typical noise flashes in the picture as seen on an analog screen. Instead it will appear as either a momentarily frozen picture or as momentarily checkered squares scattered through the picture. Therefore, as you can imagine, it would be intolerable for a commercial broadcast signal but quite acceptable for hams!

Can occupy less bandwidth. A commercial 8VSB digital broadcast signal occupies a fixed 6-MHz bandwidth and is not subject to modification. The DVB-S signal bandwidth, however, can be tailored to meet the users' requirements. Therefore, it can be made wider or significantly narrower than 6 MHz with corresponding trade-offs. If a narrower bandwidth is needed, video quality will suffer and fast motion may pixelate. By "pixelate" we mean that checkered squares will appear in the picture where the data cannot be refreshed accurately. For most ham applications, we are not showing video of car races and the person "on camera" is usually not moving rapidly, so again, this normally is not a problem. We have found that a forward error correction value of about three-quarters with a 3.125-meg Symbol rate is adequate for normal motion with two video streams in a 4-MHz channel. (See figure 2.)

Less transmit power required than analog for same range. Because the digital signal contains more data than an equivalent analog signal, less power is needed to transmit an error-free signal. Also, the signal envelope contains more peak power spread out more evenly across the occupied bandwidth allowing more information within the carrier envelope. An analog signal has most of the power closest to the signal center carrier, but the digital signal is spread out more evenly across the spectrum. As a result, the digital signal looks more square as viewed on a spectrum analyzer as seen in figure 2. As a rough rule of thumb, the digital signal transmit power can be as low as one-tenth of the power of an analog signal for the same received signal quality. Example: The ATCO digital QPSK 2.5-watt 1245-MHz signal is received about the same as its 30-watt 1260-MHz analog signal. (Both signals use identical antennas at the same elevation 10 feet apart).

It's neat to be on the cutting edge (bragging rights). Last but not least, it's neat to be able to tell people that your signal is the latest digital technology coming from a home-built amateur transmitter. A number of club members have been acquired just because of that fact. Many people like to be leaders, right?

DATV Disadvantages

Most DATV is in Europe. Up to this time, it's clear that the European hams are more creative with regard to DATV. They pioneered it in the early stages starting at the turn of the 21st century. I don't know the real reason why, but guess that many are still building their own equipment, whereas many Americans have given in to simply buying what they need and "plugging it in" to get them on the air. That's not necessarily bad, but it does limit DATV operation here in the USA.

Transmit boards are expensive. Transmit boards available from European sources are *not cheap*, and as we all know, USA hams are rather "thrifty"! The board sets usually will run over \$1500 for a 2.5-watt signal! It is therefore clear to me that the Europeans who spent a few years writing and perfecting the needed code want to be reimbursed for their effort. I can't blame them, but it doesn't sit well with our "thrifty U.S. hams," so to this date ... no economical solution.

Transmit boards are difficult to build. Well, not really, but the *hardware* is the easy part, as a number of manufac-

turers have created individual ICs at reasonable prices. However, writing the *software* code for these is another matter. What we *really* need is to have some experienced ham software engineers knowledgeable about digital TV sit down and help write some usable code for a board set. Creating the hardware around the code is “a piece of cake,” but I don’t know of anyone willing to take time away from his “real job” long enough to create useful software for the good of DATV.

Modulators require interlaced video. This is not a major drawback but one must be aware of it. To my knowledge, the software written for all boards available now require full interlaced NTSC video for error-free MPEG-2 compression to take place. Almost all cameras output interlaced video, but ID generators *do not*. The most common ID generator is the ElkTronics ID board used to generate the station ID for most ATV repeaters, but it does not have interlaced video, so as a result the signal pixelates and frequently freezes, making the signal almost unusable. I know of no commercially available interlaced video ID boards. Because of this the ATCO group custom-made one from a Sandisk picture-frame board and loaded it with the needed video ID slides. Maybe future software designs will overcome this problem.

Transmit delay of 1 to 2 seconds. There is about a 1- to 2-second latency delay during the MPEG-2 compression (transmitter) and decompression (receiver). Most of the time it is of novel interest being able to watch the analog transmission and then the digital transmission occur with a 1- to 2-second offset. However, if any DATV linking between repeaters is anticipated, it may be very cumbersome when using full duplex for people at each end to wait a couple of seconds before responding to a given comment. (Full duplex will create a 2- to 4-second delay). However, that may be fun to watch also, so who knows. Maybe that’s more entertainment!

Ungraceful fade margins. Analog has a graceful fade margin. That is, the picture is recognizable while noise and signal fading increase and decrease from snow-free down to within about 3 dB of disappearing altogether. Digital, however, is unforgiving, as it stays absolutely snow-free down to within about 1 to 2 dB of the threshold. Therefore, the digital signal will remain viewable longer, but when that “cliff effect” point is reached, the signal is totally gone with no visible traces of it. The corresponding analog signal may have excessive snow, but viewable traces of the signal remain, allowing antenna optimization efforts. Thus, analog has an advantage when receiving a weak DX signal under rapid fading conditions.

Broadcast Standards, Overview, Major Standards

- ATSC (8VSB) North America
- DVB-T (COFDM) Europe Terrestrial
- DVB-C (QAM) Europe and USA cable (numerous variations)
- DVB-H (QAM) Europe handheld
- DVB-S (QPSK) Europe and USA satellite

8VSB disadvantages

- Modulation scheme is very complex.
- Fixed 19.4-megSymbol data rate and 6-MHz bandwidth are not modifiable.
- Amplitude modulation (vestigial sideband) needs high-linearity amps.

If amps are not linear enough, too many transmit errors and screen blanks occur.

Audio channel not receivable on some TV sets.

Ham band not available on standard unmodified TVs.

430–450 MHz no good; cable setting in some TVs default to QAM.

902–915 MHz no good; above TV tuning range and crowded with Wi-Fi.

1240–1300 MHz no good; this is above TV tuning range.

Special receive converter required for ham applications.

Cannot use when receiver is in motion (no mobile operation).

DVB-T disadvantages

Receivers not in use in USA.

Needs high signal-to-noise-ratio receivers.

DVB-T set top boxes not available in USA.

DVB-C disadvantages

No common standard. Many variants used by each cable company.

Common receiver not available.

DVB-H disadvantages

No well-defined standard.

No receivers available.

DVB-S: Why is it Best for D-ATV?

DVB-S Advantage Summary

Used free-to-air receivers are readily available.

Receivers are “cheap”—\$10 to \$50 on eBay.

New receivers are \$125 at local satellite stores.

High-linearity amplifiers not required to transmit error-free signal.

If amps not linear—excessive transmit signal spectral regrowth occurs but minimal errors.

Inexpensive LDMOS “brick” amplifiers for transmit can be used and are easy to build.

Format multipath cancellation is adequate for ham use.

Modulation method not subject to motion limits—tested okay for mobile.

Less bandwidth needed than others for acceptable picture.

Bandwidth modifiable for motion/resolution trade-off selections.

Multiple video channels within single carrier possible.

Seems best for ham space shuttle D-ATV communication.

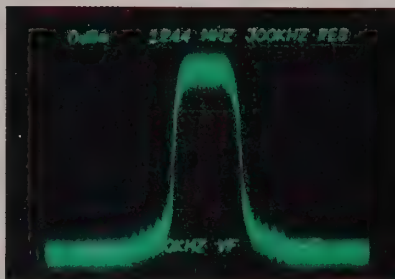
DVB-S Details

Modulation method. QPSK (Quadrature Phase Shift Keying) frequency modulation is used exclusively here. QPSK basically means that the signal is phase (FM) modulated in four quadrants of 360 degrees to essentially contain at least four times the data as a simple FM signal.

Encoding. As in most other standards, MPEG2 is used here also for data encoding. Forward error correction is employed using Viterbi and Reed-Soloman coding to correct for noise and multipath effects. The degree of correction is selectable as needs dictate, making DVB-S very desirable because it allows the user to change it for various conditions.

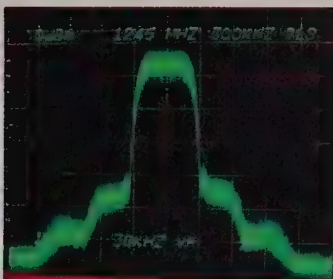
Linearity requirements. Linear amplifiers in the transmit chain can become *very* expensive. Therefore it is important for ham use to employ the transmission method most tolerant of non-linearities. DVB-S is it! Since the modulation method is

Square sides with
very little sideband
energy.



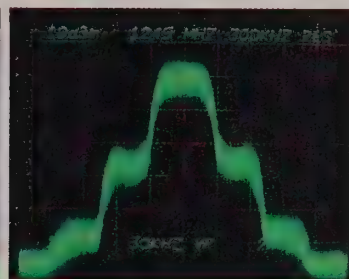
Output from modulator
Level ~ 2 milliwatts

Increased spectral
regrowth in first amp.
Is about 30dB below
carrier



Output from Kuhne
2.5 watt "hi linearity"
amp

Spectral regrowth
amplified in second amp.
is now only 20dB below
carrier.



Output from 18 watt
LDMOS brick amp
before output filter

Figure 3. Comparison of signals at various power levels.

frequency modulation, it is inherently insensitive to non-linearities. This is not entirely so, but it is found that an amplifier can be close to its 1-dB compression point before the error correction approaches its limit. This is *huge*, as it opens up the transmitter design choice tremendously. Simple LDMOS "brick" amplifiers such as the Mitsubishi RA18H1213G unit are ideal for use on the 1240–1300 MHz band to get a 10-watt (average) digital signal from as little as a 50-milliwatt source. That brick has a bias input allowing for adjustment of FM or linear operation, making it easy to see what the limit is for a given configuration. Now non-linearities *do* cause other problems, though. Each time the signal passes through an amplifier stage, it creates spectral re-growth in the output waveform proportional to the degree of non-linearity. These are sidebands above and below the main envelope at a reduced amplitude level. Therefore, although the signal has minimum errors, the overall bandwidth will be wider. This may be a problem in some cases where the allocated channel is defined or where it just makes sense to minimize spectrum interference. The bottom line is to choose the highest linearity amp affordable and then use a good interdigital type of steep-skirted bandpass filter to remove the remaining sidebands. See the spectrum analyzer comparisons in figure 3.

Power level measurements. At this point it is worth noting that output-power-level measurements using a standard Bird wattmeter are *not* accurate. The output

spectrum envelope is somewhat rectangular instead of sinusoidal, so average power measurements do not apply. Because of this rectangular waveshape, most of the power is at peak values longer, making measurements with a Bird or bolometer wattmeter read the measurements higher than they actually are. I personally feel that the only meaningful value is the actual peak reading obtained reliably with a spectrum analyzer. If you use a Bird wattmeter, I would divide its reading by at least three to get the actual transmit power. Also, when designing an amplifier chain, I'd make sure the amplifier input will handle 10 times more input power than the peak value of the digital signal (100-mw peak DATV signal to a 100-mw rated amplifier to prevent excessive power dissipation).

ATCO Repeater Summary

The ATCO Group Inc., originally

organized in 1980, is located in Columbus, Ohio and serves approximately 85 ATVers within a 50-mile radius. It is our purpose to further the exchange of information and cooperation among members; promote amateur television knowledge, fraternalism, and individual operating excellence; and conduct activities that advance ATV general interest and welfare.

We operate an ATV repeater installed in the fall of 1994 with five outputs (427.25 MHz AM, 1245 MHz DATV (DVB-S), 1260 MHz FM, 2433 MHz FM, and 10.450 GHz FM) and four inputs (439.25 MHz, 1280 MHz analog/DATV, 2398 MHz, and 10.350 GHz). A 3-watt DVB-S output was installed in January 2004 and has been in operation 24/7 since then. A 10-watt amp was added in June 2009.

We conduct weekly net meetings on 147.48 MHz at 9:00 PM EST/EDT on Tuesdays which serves to introduce new-



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NORTH AMERICA
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comers, discuss ATV topics, and announce news. It is the simplex "gathering spot" for audio activity with control capabilities for the ATV repeater.

Recently, we began streaming our weekly net meetings on the internet for the benefit of those beyond the metropolitan Columbus, Ohio area. All are welcome to join in. Just tune in at <<http://www.batc.tv>>, select "ATV Repeaters," and then scroll down to WR8ATV and click on "view stream." There you can both see and hear us during the net starting at 9 PM. The streaming is on every Tuesday from approximately 8:30 PM EST/EDT till about 10 PM or whenever the net closes.

We publish a newsletter four times a year containing local events, late-breaking ATV news, construction articles, tips/techniques, meeting announcements, and whatever else we can find that has ATV interest. The newsletter and other ATV topics can be viewed on our homepage at: <<http://www.atco.tv>>.

We help provide security video coverage each year for various local public events such as our annual Independence Day fireworks show (which draws over 500,000 observers), various parades, local air shows, and observation video of airport disaster drill activity. We also provide local severe weather observation to help identify potential damaging storms for the public.

We have spring and fall events where we gather to share ideas, plan future activities, enjoy free food, have door prizes (for everyone), and usually conduct a mini hamfest with trunk sales in the meeting-place parking lot. We normally have a few pizza parties where we can enjoy the companionship of others.

We are working on a link to connect the Columbus and Dayton repeaters. We found an ideal site halfway between us (35 miles from Columbus and 30 miles from Dayton) that we have been working on for a number of years now. We had it operational before the Dayton repeater had to relocate and we now have started over. We are considering a digital link but are concerned about the latency issues. That is, there is a 1- to 2-second delay in sending and receiving the signal, so a full-duplex link may turn out to be difficult for acceptable communication. With a repeater link, the delay is effectively doubled, because it occurs at both ends!

ATCO DVB-S Operational Results

Our digital (DVB-S) 1245-MHz signal has been operational since January 2004 with a 2.5-watt signal receivable within about a 20-mile range. Recently we added a power amp to boost the output to about 10 watts average, extending the range to roughly 40 miles. There are about 15 ATCO club members with digital receive capability using surplus "Free To Air" digital receivers obtained on eBay for about \$50 each. Some additional people have obtained various receivers from eBay and elsewhere for \$10 to \$75. All have worked okay and have had no trouble locking onto our DVB-S signal using only a minimal loop Yagi antenna mounted less than 30 feet in the air.

I personally have a 20-element loop Yagi mounted 30 feet up my tower permanently pointed to the repeater 15 miles away connected to 75 feet of 7/8-inch heliax. In the shack I have a two-way splitter with my analog receiver connected to one port

and the digital receiver connected to the other. Tests have proven there is 10 dB of excess signal needed for simultaneous P5 picture reception on both receivers.

The transmitter DVB-S board set of choice is the Netherlands D-ATV boards. We use two MPEG-2 encoder boards connected to an I/Q baseband board and then to a 1.8-milliwatt modulator/exciter board providing us with two channels of video. The 1.8-milliwatt signal is fed to a Kuhne Electronics ultra linear amplifier (we were told high-linearity amps were a *must* at the time) costing about \$500 alone. The Kuhne 2.5-watt output was connected directly to the antenna until recently when an LDMOS "brick" amp was added to produce a 10-watt (average by Bird wattmeter) signal. That output is fed to a custom-made inter-digital bandpass amp with steep skirts with a bandpass of 5 MHz. Using 3.125-meg Symbol rate with a three-quarter FEC, our overall signal is about 4 MHz wide excluding the spectral regrowth sidebands. This correlates closely with the formula: signal bandwidth = $1.3 \times$ symbol rate. With the filter in place the resulting signal on a spectrum analyzer looks very clean with the regrowth signal down more than 50 dB from peak carrier.

We have tested mobile operation with great success. The DVB-S modulation scheme is supposed to be reasonably insensitive to motion, and we proved that it indeed is! The vehicle in motion was accelerated to over 50 mph with no loss of signal. In fact, the normal signal flutter and fading was very surprisingly non-existent. While traveling under a bridge underpass, the signal was maintained with only a momentary picture freeze unnoticeable if not looking for it. The normal analog mobile ATV signal flutter, which was very annoying, was virtually gone with digital!

Finally, a word about why we ended up using 1245 MHz for our digital signal. We originally had our analog signal on 1250 and digital on 1260. One morning my wife answered the phone and told me, "You had better take this call!"

It was the FCC monitor from Detroit who had been tracking our analog ATV signal because of an interference complaint! It turns out that since our 1250-MHz signal identified with a bulletin-board sequence for four minutes every half hour, it was interfering with the local Ohio Department of Transportation (ODOT) reception from a Russian GPS 1250-MHz signal used in its surveying efforts. Since ODOT couldn't find the interference source after six months of searching, they called the FCC. The FCC drove from Detroit to Columbus and found our signal source after about a half hour.

I was then contacted and initially told that we were okay and legally operating within our assigned band. Later I was notified that because of a recent FCC clause saying that interference to Radio-Navigation was prohibited in the 23-cm band, we had to vacate. We finally ended up with our analog signal on 1260 MHz and the digital one on 1245 MHz, leaving 1250 MHz clear. That was okay until I added the power amp. Now the added spectral regrowth extended the upper bandpass to 1250 and again caused them interference. (They were not shy about telling me so.) After I added the interdigital filter, no phone calls! This is a story worth telling, because it demonstrates the real need for a good bandpass filter. I still tell others how we interfered with a Russian GPS satellite! It sounds bizarre until you know the details.

CQ's 6 Meter and Satellite WAZ Awards

(As of January 1, 2010)

By Floyd Gerald,* N5FG, CQ WAZ Award Manager

6 Meter Worked All Zones

No.	Callsign	Zones needed to have all 40 confirmed
1	N4CH	16,17,18,19,20,21,22,23,24,25,26,28,29,34,39
2	N4MM	17,18,19,21,22,23,24,26,28,29,34
3	J1ICQA	2,18,34,40
4	K5UR	2,16,17,18,19,21,22,23,24,26,27,28,29,34,39
5	EH7KW	1,2,6,18,19,23
6	K6EID	17,18,19,21,22,23,24,26,28,29,34,39
7	K0FF	16,17,18,19,20,21,22,23,24,26,27,28,29,34
8	JF1IRW	2,40
9	K2ZD	2,16,17,18,19,21,22,23,24,26, 28,29,34
10	W4VHF	16,17,18,19,21,22,23,24,25,26,28,29,34,39
11	G0LCS	1,6,7,12,18,19,22,23,28,31
12	JR2AUE	2,18,34,40
13	K2MUB	16,17,18,19,21,22,23,24,26,28,29,34
14	AE4RO	16,17,18,19,21,22,23,24,26,28,29,34,37
15	DL3DXX	18,19,23,31,32
16	W5OZI	2,16,17,18,19,20,21,22,23,24,26,28,34,39,40
17	WA6PEV	3,4,16,17,18,19,20,21,22,23,24,26,29,34,39
18	9A8A	1,2,3,6,7,10,12,18,19,23,31
19	9A3JI	1,2,3,4,6,7,10,12,18,19,23,26,29,31,32
20	SP5EWY	1,2,3,4,6,9,10,12,18,19,23,26,31,32
21	W8PAT	16,17,18,19,20,21,22,23,24,26,28,29,30,34,39
22	K4CKS	16,17,18,19,21,22,23,24,26,28,29,34,36,39
23	HB9RUZ	1,2,3,6,7,9,10,18,19,23,31,32
24	JA3IW	2,5,18,34,40
25	IK1GPG	1,2,3,6,10,12,18,19,23,32
26	W1AIM	16,17,18,19,20,21,22,23,24,26,28,29,30,34
27	K1LPS	16,17,18,19,21,22,23,24,26,27,28,29,30,34,37
28	W3NZL	17,18,19,21,22,23,24,26,27,28,29,34
29	K1AE	2,16,17,18,19,21,22,23,24,25,26,28,29,30,34,36
30	IW9CER	1,2,6,18,19,23,26,29,32
31	IT9IPQ	1,2,3,6,18,19,23,26,29,32
32	G4BWP	1,2,3,6,12,18,19,22,23,24,30,31,32
33	LZ2CC	1
34	K6MIO/KH6	16,17,18,19,23,26,34,35,37,40
35	K3KYR	17,18,19,21,22,23,24,25,26,28,29,30,34
36	YV1DIG	1,2,17,18,19,21,23,24,26,27,29,34,40
37	K0AZ	16,17,18,19,21,22,23,24,26,28,29,34,39
38	WB8XX	17,18,19,21,22,23,24,26,28,29,34,37,39
39	K1MS	2,17,18,19,21,22,23,24,25,26,28,29,30,34
40	ES2RJ	1,2,3,10,12,13,19,23,32,39
41	NW5E	17,18,19,21,22,23,24,26,27,28,29,30,34,37,39
42	ON4AOI	1,18,19,23,32
43	N3DB	17,18,19,21,22,23,24,25,26,27,28,29,30,34,36
44	K4ZOO	2,16,17,18,19,21,22,23,24,25,26,27,28,29,34
45	G3VOF	1,3,12,18,19,23,28,29,31,32
46	ES2WX	1,2,3,10,12,13,19,31,32,39
47	IW2CAM	1,2,3,6,9,10,12,18,19,22,23,27,28,29,32
48	OE4WHG	1,2,3,6,7,10,12,13,18,19,23,28,32,40
49	T1SKD	2,17,18,19,21,22,23,26,27,34,35,37,38,39
50	W9RPM	2,17,18,19,21,22,23,24,26,29,34,37
51	N8KOL	17,18,19,21,22,23,24,26,28,29,30,34,35,39
52	K2YOF	17,18,19,21,22,23,24,25,26,28,29,30,32,34
53	WA1ECF	17,18,19,21,23,24,25,26,27,28,29,30,34,36
54	W4TJ	17,18,19,21,22,23,24,25,26,27,28,29,34,39
55	JM1SZY	2,18,34,40
56	SM6FHZ	1,2,3,6,12,18,19,23,31,32
57	N6KK	15,16,17,18,19,20,21,22,23,24,34,35,37,38,40
58	NH7RO	1,2,17,18,19,21,22,23,28,34,35,37,38,39,40
59	OK1MP	1,2,3,10,13,18,19,23,28,32
60	W9JUV	2,17,18,19,21,22,23,24,26,28,29,30,34
61	K9AB	2,16,17,18,19,21,22,23,24,26,28,29,30,34
62	W2MPK	2,12,17,18,19,21,22,23,24,26,28,29,30,34,36
63	K3XA	17,18,19,21,22,23,24,25,26,27,28,29,30,34,36
64	KB4CRT	2,17,18,19,21,22,23,24,26,28,29,34,36,37,39
65	JH7IFR	2,5,9,10,18,23,34,36,38,40
66	K0SQ	16,17,18,19,20,21,22,23,24,26,28,29,34
67	W3TC	17,18,19,21,22,23,24,26,28,29,30,34
68	IK0PEA	1,2,3,6,7,10,18,19,22,23,26,28,29,31,32
69	W4UDH	16,17,18,19,21,22,23,24,26,27,28,29,30,34,39
70	VR2XMT	2,5,6,9,18,23,40
71	EH9IB	1,2,3,6,10,17,18,19,23,27,28
72	K4MQG	17,18,19,21,22,23,24,25,26,28,29,30,34,39
73	JF6EZY	2,4,5,6,9,19,34,35,36,40
74	VE1YX	17,18,19,23,24,26,28,29,30,34
75	OK1VBN	1,2,3,6,7,10,12,18,19,22,23,24,32,34
76	UT7QF	1,2,3,6,10,12,13,19,24,26,30,31
77	K5NA	16,17,18,19,21,22,23,24,26,28,29,33,37,39
78	I4EAT	1,2,6,10,18,19,23,32
79	W3BTX	17,18,19,22,23,26,34,37,38
80	JH1HHC	2,5,7,9,18,34,35,37,40
81	PY2RO	1,2,17,18,40M,19,21,22,23,26,28,29,30,38,39,40
82	W4UM	18,19,21,22,23,24,26,27,28,29,34,37,39
83	I5KG	1,2,3,6,10,18,19,23,27,29,32
84	DF3CB	1,2,12,18,19,32
85	K4PI	17,18,19,21,22,23,24,26,28,29,30,34,37,38,39
86	WB8TGY	16,17,18,19,21,22,23,24,26,28,29,30,34,36,39
87	MU0FAL	1,2,12,18,19,22,23,24,26,27,28,29,30,31,32
88	PY2BW	1,2,17,18,19,22,23,26,28,29,30,38,39,40
89	K4OM	17,18,19,21,22,23,24,26,28,29,32,34,36,38,39
90	JH0BBE	2,33,34,40
91	K6QXY	17,18,19,21,22,23,34,37,39

Satellite Worked All Zones

No.	Callsign	Issue date	Zones Needed to have all 40 confirmed
1	KL7GRF	8 Mar. 93	None
2	VE6LQ	31 Mar. 93	None
3	KD6PY	1 June 93	None
4	OH5LK	23 June 93	None
5	AA6PJ	21 July 93	None
6	K7HDK	9 Sept. 93	None
7	WINU	13 Oct. 93	None
8	DC8TS	29 Oct. 93	None
9	DG2SBW	12 Jan. 94	None
10	N4SU	20 Jan. 94	None
11	PA0AND	17 Feb. 94	None
12	VE3NPC	16 Mar. 94	None
13	WB4MLE	31 Mar. 94	None
14	OE3JIS	28 Feb. 95	None
15	JA1BLC	10 Apr. 97	None
16	F5ETM	30 Oct. 97	None
17	KE4SCY	15 Apr. 01	10,18,19,22,23, 24,26,27,28, 29,34,35,37,39
18	N6KK	15 Dec. 02	None
19	DL2AYK	7 May 03	2,10,19,29,34
20	N1HOQ	31 Jan. 04	10,13,18,19,23, 24,26,27,28,29, 33,34,36,37,39
21	AA6NP	12 Feb. 04	None
22	9V1XE	14 Aug. 04	2,5,7,8,9,10,12,13, 23,34,35,36,37,40
23	VR2XMT	01 May 06	2,5,8,9,10,11,12,13,23,34,40
24	XE1MEX	19 Mar. 09	2,17,18,21,22,23,26,34,37,40

CQ offers the Satellite Work All Zones award for stations who confirm a minimum of 25 zones worked via amateur radio satellite. In 2001 we "lowered the bar" from the original 40 zone requirement to encourage participation in this very difficult award. A Satellite WAZ certificate will indicate the number of zones that are confirmed when the applicant first applies for the award.

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Rules and applications for the WAZ program may be obtained by sending a large SAE with two units of postage or an address label and \$1.00 to the WAZ Award Manager: Floyd Gerald, N5FG, 17 Green Hollow Rd., Wiggins, MS 39577. The processing fee for all CQ awards is \$6.00 for subscribers (please include your most recent CQ or CQ VHF mailing label or a copy) and \$12.00 for nonsubscribers. Please make all checks payable to Floyd Gerald. Applicants sending QSL cards to a CQ Checkpoint or the Award Manager must include return postage. N5FG may also be reached via e-mail: <n5fg@cq-amateur-radio.com>.

*17 Green Hollow Rd., Wiggins, MS 39577; e-mail: <n5fg@cq-amateur-radio.com>

SATELLITES

Artificially Propagating Signals Through Space

The New, The Old, and The Meetings: ARISSat-1, SO-67, HO-68, UO-11, AMSAT Symposium, and QCWA

Two new amateur radio satellites, SO-67 and HO-68, were launched recently. One old "Bird," UO-11, returned to life briefly, and progress is being made on design, construction, and testing of ARISSat-1. I will discuss these satellites and go over the process of integrating them into the active satellite inventory. Reports on the AMSAT 40th Anniversary Celebration during the AMSAT Space Symposium and of a visit to the Arecibo Observatory in Puerto Rico during the QCWA Cruise Meeting will round out this column (photos of this event are shown throughout the column).

ARISSat-1

Shortly after the Amateur Radio on the International Space Station (ARISS) meeting in the Netherlands, we learned that the Russian ORLAN Space Suit that was to be used for SuitSat-2 had to be discarded due to a shortage of storage space on the International Space Station (ISS). This development left ARISS without a framework to house the planned electronics hardware. Fortunately, the free up-mass allocation for delivery of the hardware and the launch EVA commitment were still retained. This led to the rapid design of an alternate hand-launchable space frame to house the hardware. This new satellite has now been renamed ARISSat-1.

Fabrication of the space frame and the electronics hardware is now nearly complete. Software is still in development utilizing prototype hardware and is now nearly ready for integration with the flight hardware. Final integration with the flight hardware is planned for early 2010. A Flight Safety review of the entire satellite is now in progress and should also be complete in early 2010. Current plans are to ship ARISSat-1 to Russia for up-mass to the ISS in mid 2010. Final



John Ross, WA5WOD, Mike Scarcella, WA5TWT, Andy MacAllister, W5ACM, at the QCWA meeting on board the MS Eurodam.

deployment will be on a Russian EVA in late 2010 or 2011.

ARISSat-1 will have many capabilities, including a Software Defined Linear Transponder (SDX), SSTV, FM voice beacon, and a CW beacon. It will contain batteries, a smart battery charge regulator, and solar panels to provide a useful life for the satellite that should equal its time in space. It will re-enter within six months to a year from launch.

ARISSat-1 hardware and software are being developed in a modular form so that the designs can be reused on other future satellites. ARISSat-1 will thus become an inexpensive test bed for future AMSAT satellites.

SO-67 (SumbandilaSat)

The second South African satellite, SumbandilaSat, was launched by a Russian vehicle from Baikonur Cosmodrome in Kazakhstan on 17 September 2009. The amateur radio transponder is a secondary feature of the satellite and has had to take a "back seat" to the primary experiments; however, it is being checked out and operated on a non-interference basis.



Bill Hulse, W5NI, who was also at the QCWA meeting on the MS Eurodam.

The FM voice transponder is very strong (5 watts) and has some unusual operating characteristics that require some newly developed custom operating techniques. For example, care must be exercised to avoid over-deviation. A long "squell tail" on the transponder coupled with PL access has created the necessity

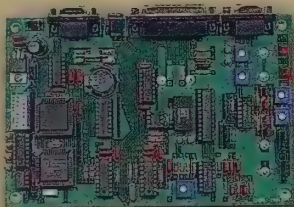
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The 1000-ft. diameter reflector of the radio telescope at the Arecibo Observatory in Puerto Rico.

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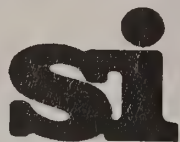
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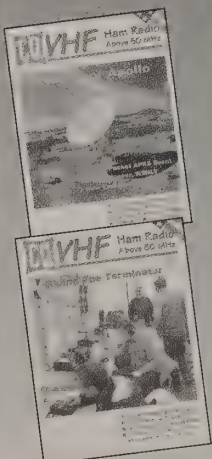


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The plaque describing the Arecibo radio telescope's reflector.

for new operating techniques. Hams are getting used to these techniques and operations now are very successful.

Scheduling of the transponder is under the control of the primary South African ground station; however, this ground station is seeking advice from regional controllers around the world for development of the transponder schedule on a continuing basis. Ultimately, there will more amateur radio operation on the "Bird" when the primary experiments are complete. Full details are on the AMSAT-SA web page: <<http://www.amsat-sa.org.za/>>.

Current frequencies and modes are:

Mode V/U (J) FM Voice Repeater (Use narrow FM on the uplink)
Uplink: 145.8750 MHz FM,
PL 233.6 Hz.
Downlink 435.3450 MHz FM

HO-68 (Hope OSCAR 68)

Originally known as XIWANG-1 (XW-1), or Hope-1, this dedicated amateur radio satellite was launched on 15 December 2009 from China on a Chinese launch vehicle. It is in a High Low Earth Orbit (High LEO) at 1200 km altitude, giving it a relatively large footprint. On an overhead pass at my QTH (Fort Worth, Texas) it is possible to have the entire North American continent in the footprint at once. The eastern third of the U.S. should have relatively easy access to western Europe, and the western two-thirds of the U.S. should have access to Hawaii. Access to the northern quarter of South America is available from quite a bit of the U.S.

HO-68 has a CW beacon, a linear V/U transponder, a V/U FM voice transponder, and a V/U packet capability. Initial testing of all of these capabilities has been very successful. I am especially impressed by the linear transponder. It reminds me somewhat of AO-07, AO-10, and AO-13.



First view of the feed of the Arecibo Observatory in Puerto Rico.

Full details are available on the China AMSAT web page: <<http://www.camsat.cn>>. Current frequencies and modes are as follows:

Mode V/U (J) FM Voice Repeater
(30 dbm [1 w]):
Uplink: 145.8250 MHz FM, PL 67.0 Hz.
Downlink: 435.6750 MHz FM

Mode V/U (J) Linear Transponder
(Inverting) (30 dbm [1 w]):
Uplink: 145.9250–145.9750 MHz
SSB/CW
Downlink: 435.7650–435.7150 MHz
SSB/CW

Mode V/U (J) PacSat BBS (30 dbm
[1 w]):
Uplink: 145.8250 MHz AFSK 1200 BPS
Downlink: 435.6750 MHz AFSK
1200 BPS

Mode Beacon (23 dbm [200 mw]):
Downlink: 435.7900 MHz CW

Watch this one carefully as it develops!

UO-11

On 1 March 1984, UO-11 was placed in orbit on a Delta launcher from Vandenberg AFB in California. This satellite was developed by the University of Surrey in England with additional help from all over in six months. After a rocky start, it went on to have a very successful long time in space. It carried the first store-and-forward digital communications experiment and a number of other capabilities. It retained nearly full function until about the year 2000 and started to lose function after that. About a year ago (November 2008) it went off the air completely and was declared "legally

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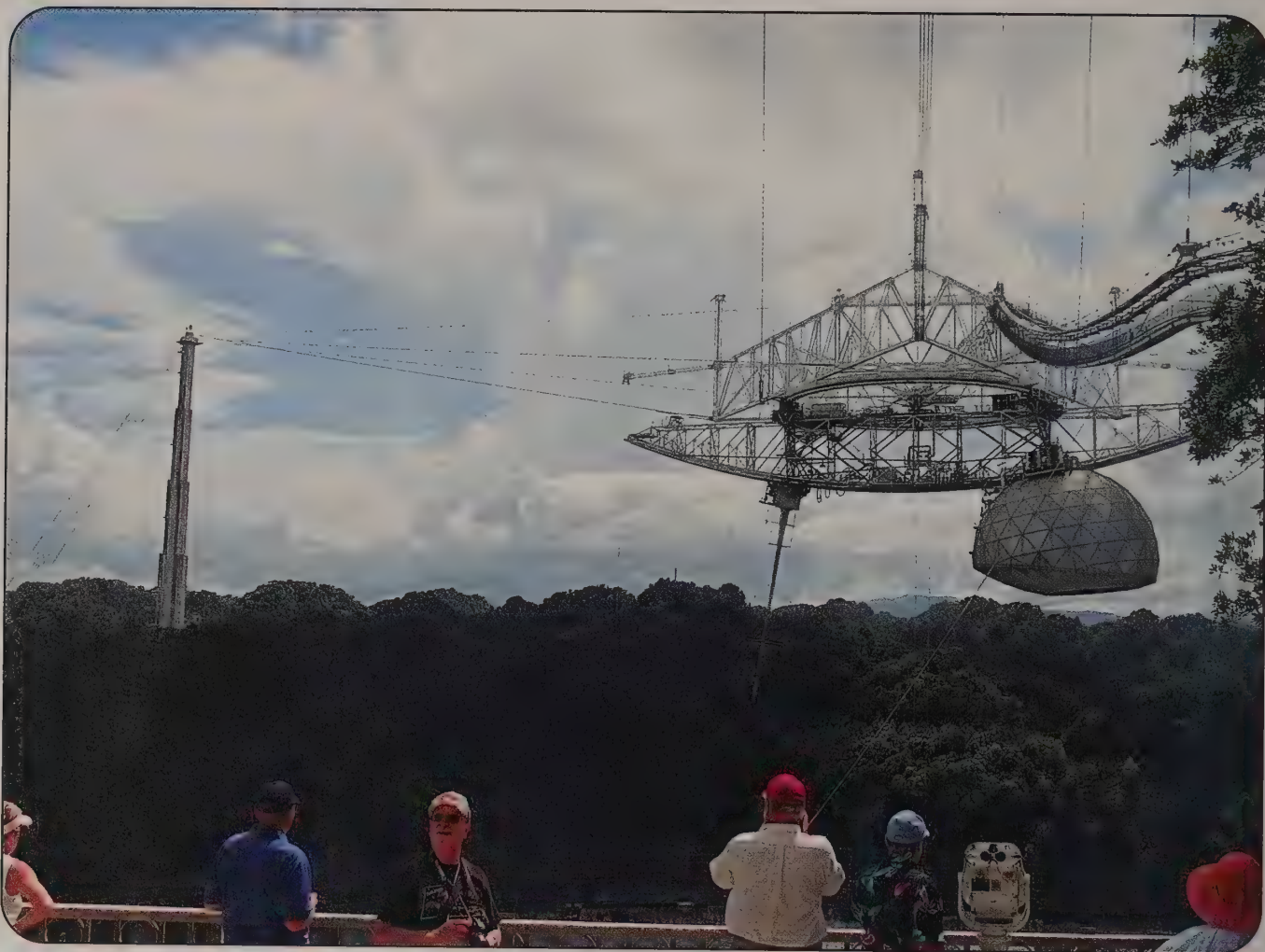
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Overall view of the feed.

dead.” Its old familiar buzz was heard again in November 2009! It lasted for only a few days but went away again. It has returned once more since then and may be back occasionally. Current theories about its operation can be found at: <http://www.g3cww.co.uk/>.

AMSAT Space Symposium 2009

On 8–11 October 2009, AMSAT celebrated its 40th anniversary during the AMSAT Space Symposium 2009 at the Baltimore-Washington International Airport Four Points Sheraton. The AMSAT Board of Directors met on Thursday and Friday, the symposium was on Friday through Sunday, and the ARISS Ops Team met on Sunday. The AMSAT Annual General Meeting was on Saturday afternoon. Martin Collins of the National Air and Space Museum was the after dinner speaker at the Saturday

evening banquet. The AMSAT Area Coordinators Breakfast was on Sunday morning before the IARU International Satellite Forum.

After welcoming the incoming board members, a new slate of officers was elected and appointed. Complete minutes of the BOD meeting are available in the *AMSAT Journal*. Highlights were the planning and status of ARISSat-1, discussion of the next major AMSAT Project (a 1U Cubesat), potential alliance with the University of Florida in Gainesville for educational outreach projects and potential location of the laboratory, and alliance with the State University of New York at Binghamton for educational outreach projects. All of these items were summarized for the membership at the annual meeting by President Barry Baines, WD4ASW, on Saturday afternoon.

Papers on a variety of satellite-related topics were presented on Friday and Saturday. *Proceedings* of the symposium

are available from AMSAT. All attendees were given a copy of the *Proceedings* and of Bill Tynan, W3XO’s great new book entitled *AMSAT – The First Forty Years*.

The ARISS Operations group met on Sunday morning for the first “Face-to-Face Meeting” of this group at the hotel and on EchoLink worldwide to discuss the direction of ARISS Operations. This meeting provided a valuable forum for the group.

I went away from these meetings with a renewed confidence in AMSAT. The new organization has faced up to a realistic set of goals and appears to have a new slate of officers who can carry them out.

QCWA

This may seem to be an unusual turn of events to discuss the Quarter Century Wireless Association (QCWA) in an amateur radio satellites column, but there



Feed detail.

are reasons. First, the meeting was to be held on the *MS Eurodam* of the Holland America Line while touring the eastern Caribbean. Second, several of my friends—mostly fellow “satelliters”—were going on the trip, and last, the highlight of the trip for me was to be a visit to the

Arecibo Observatory in Puerto Rico. Even if you are not familiar with radio astronomy you probably have heard of and/or seen the Arecibo Radio Telescope in movies such as “Contact” and the “Agent 007” offerings. We had a half-day dedicated tour of the telescope. I have

included photos of some of the people, and parts of the telescope. This is a truly amazing device and ranks as one of the marvels of the engineering world.

Oh, yes! Some of us did work satellites from the deck of the *Eurodam* while at sea, but unfortunately satellite pass times and scheduled eating times were in conflict on numerous occasions. Guess which event won! The food on these cruise ships is excellent, by the way!

Summary

Let's welcome the “new Birds” into the flock and continue to listen for the “old Birds.” Congratulations to South Africa and China for excellent additions to the “flock.”

Please continue to support AMSAT in its plans for the future of the amateur radio satellites. AMSAT is now updating its web page at <<http://www.amsat.org>> on a much more regular basis. Satellite details are updated regularly at <<http://www.amsat.org/amsat-new/satellites/status.php>>.

'Til next time!

73, Keith, W5IU



Greater detail of the feed.

ATV

Amateur Television – Methods and Applications

Digital Amateur Television – An Introduction

Tom Dean, KB1JJJ, is currently a junior at the United States Military Academy at West Point. Tom has been licensed since 2002. His operating interests include HF contesting and digital modes. He is active in the Academy's amateur radio club, W2KGY, where he is involved in building the Academy's first CubeSat. Tom is a student of electrical engineering. His academic interests include signal processing, software defined radio, and complex variable methods in partial differential equations.

In his column, Tom plans to explore non-traditional methods and applications of Amateur Television. He also wants to help show that building an amateur television station is not quite as difficult as it might appear. It has been a long-standing goal of his to have an easily-obtainable digital amateur radio setup that would operate in manner comparable to current analog methods in amateur television. —N6CL

*e-mail: <Thomas.Dean@usma.edu>

Amateur Television has been on the UHF bands for quite some time. In the past, it has been standard practice to match the standard for commercial broadcasting of television on the amateur bands, making operating ATV easily accessible to the typical ham. The recent mandate from the FCC that all terrestrial broadcasts must be digital raises the possibility of making digital amateur television, or D-ATV, common practice. There are many advantages to transmitting digital signals. The use of compression allows for the ability to send higher resolution videos in the same bandwidth. Additionally, forward error correction schemes allow for weaker signals to be received with less error. Unfortunately, transmitting the digital signal is a slightly more difficult task than standard ATV.

This issue's column provides an overview of digital television emission standards, and presents several theoretical approaches that could be used to create a digital television station. There has been no widespread use of D-ATV other

than experimentation, but hopefully in the near future this will become as common as ATV is today.

Digital Television and the ATSC

There are several possible ways to encode and modulate a digital television signal. Cable-based systems tend to rely on a modulation technique known as 64-level Quadrature Amplitude Modulation (64-QAM). Alternatively, terrestrial broadcast stations rely on a different modulation method that is similar to that used by analog television, 8-level Vestigial Sideband (or 8-VSB). This type of emission is more suited for terrestrial channels, and is therefore used in the Advanced Television Systems Committee (ATSC) standard which was adopted by the FCC. The standard also incorporates a forward-error-correction scheme which is optimized for a terrestrial environment. If a D-ATV station uses a commonly accepted standard, the

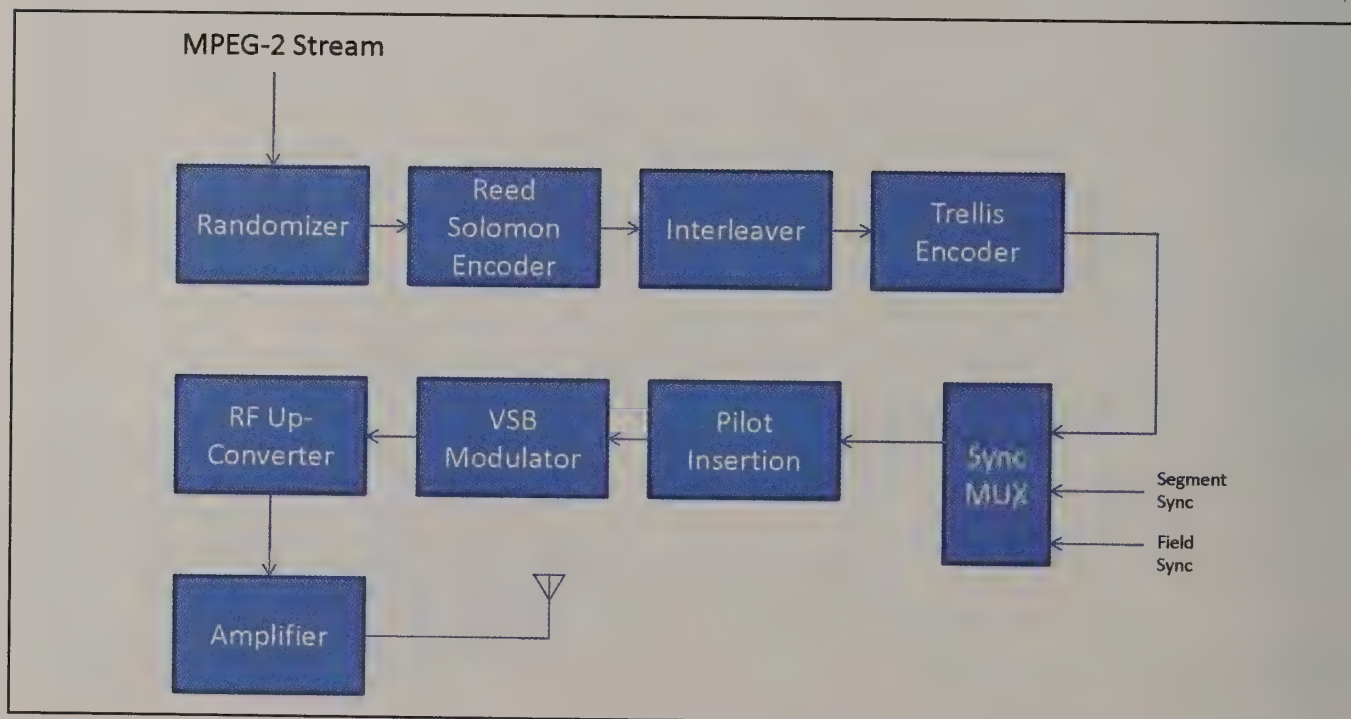


Figure 1. Block diagram of an ATSC transmitter.

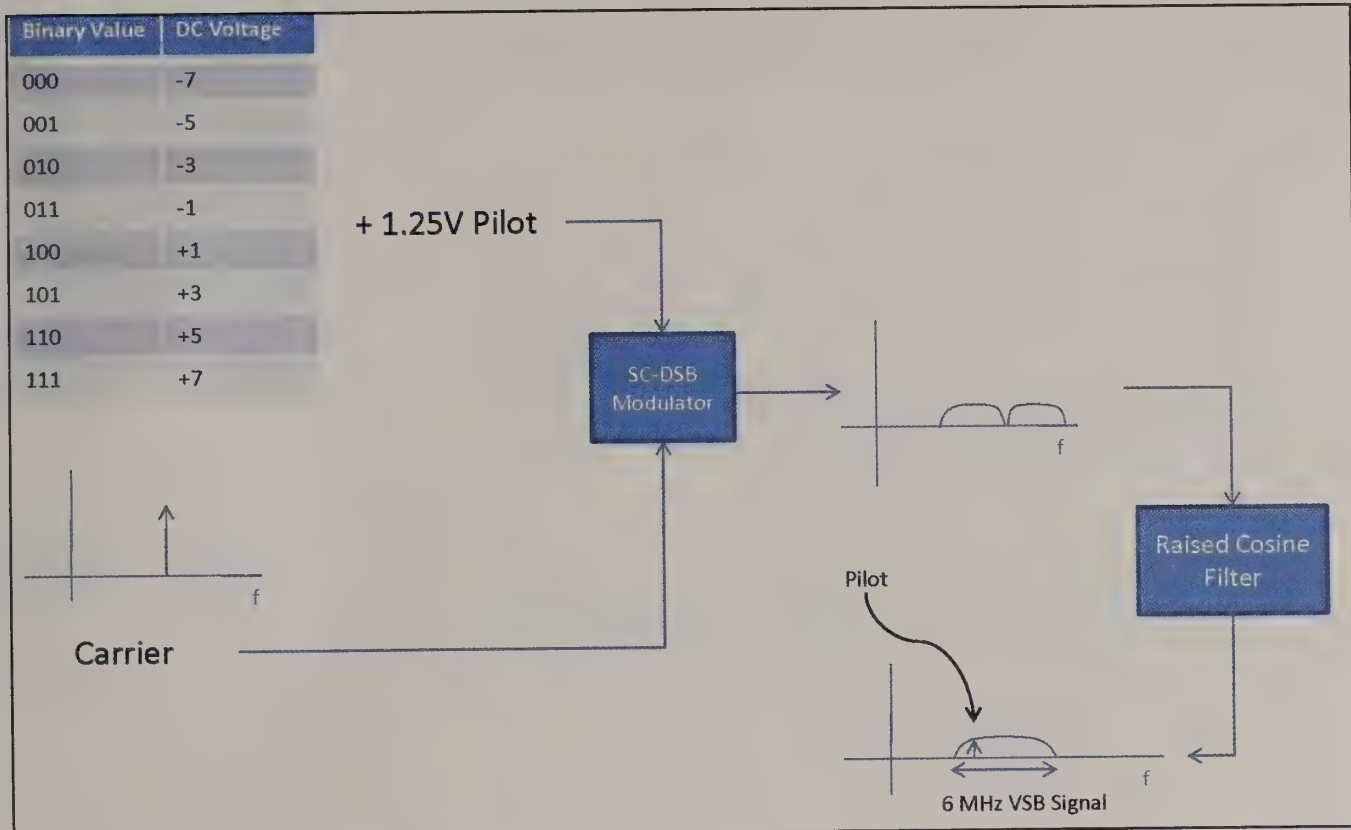


Figure 2. The VSB modulation process.

demodulation of the signal becomes much like the demodulation of an ATV signal; the signal must be down-converted to a standard broadcast TV frequency and can then be displayed on an off-the-shelf digital television. For this reason, I would recommend the use of ATSC for any D-ATV projects.

Emission Overview

A video signal must go through a series of steps before it becomes an ATSC signal. The signal must first be digitized and compressed into an MPEG-2 stream. This stream can contain both the audio and video signal of the transmission. It is not uncommon to find cameras that will output an MPEG-2 stream, as this is the same format adapted by the HDV standard used in most camcorders. Additionally, there many commercial boards available that will digitize and compress an analog video signal.

The MPEG-2 stream is then taken through forward error correction. The data is typically first randomized¹, and then sent to a Reed-Solomon encoder followed by an interleaver and a Trellis Encoder². There are options within the standard to allow additional forward-error correction to be added, at the expense of video quality, to help in more adverse conditions. Synchronization signals are then inserted into this stream. This separates the signal into fields and segments. The purpose of the synchronization signals is to help the receiver lock onto the signal.

At the heart of the ATSC standard lies the vestigial sideband modulation (VSB). This method of modulation is very similar to double-sideband modulation. In order to modulate a digital stream into VSB, three bits at a time are mapped to one of eight possible DC voltages. A small DC voltage is also added to each

symbol, which results in a small pilot carrier being generated in the final signal. This pilot signal helps the receiver to lock on and detect the ATSC signal. This signal is then mixed with a carrier to create a double-sideband, suppressed-carrier signal. The signal is then turned into a VSB signal simply by running it through a filter which removes most of the lower sideband, leaving the entire upper sideband and a portion of the lower sideband. This modulation method is very similar to the analog NTSC standard, and, like the analog signal, fits with a 6-MHz channel. ATSC is capable of providing up to 19.39 Mbps of data in this channel.

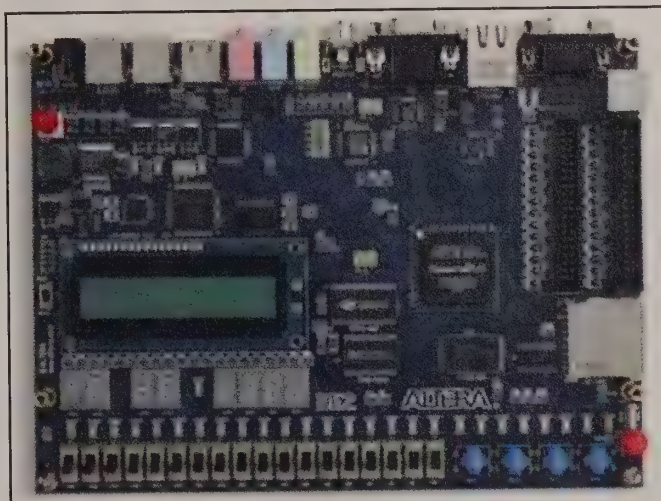


Figure 3. The Altera DE2 board. (Courtesy of Altera)



Figure 4. An HF carrier generated by the DE2 using the video DAC and the corresponding FFT.

Possible Approaches to a D-ATV Station

Unfortunately, there are not a large number of commercial systems available that create video signals in the ATSC format. While it is fairly common to see an analog signal be modulated into RF to be displayed on the TV, interchange of digital signals is typically accomplished using non-RF techniques such as HDMI or similar interfaces. This makes it a slightly more difficult problem to be able to transmit digital video.

Since we are already dealing with a digital signal, it lends itself well to be processed via software-defined radio. If you have dealt with SDR, you are most likely familiar with the Universal Software Radio Peripheral, or USRP. This board was developed with the intention of demodulating HDTV television signals and has done so with some success. The USRP is programmed through GnuRadio, which links together processing blocks of C code using Python script. Creating an

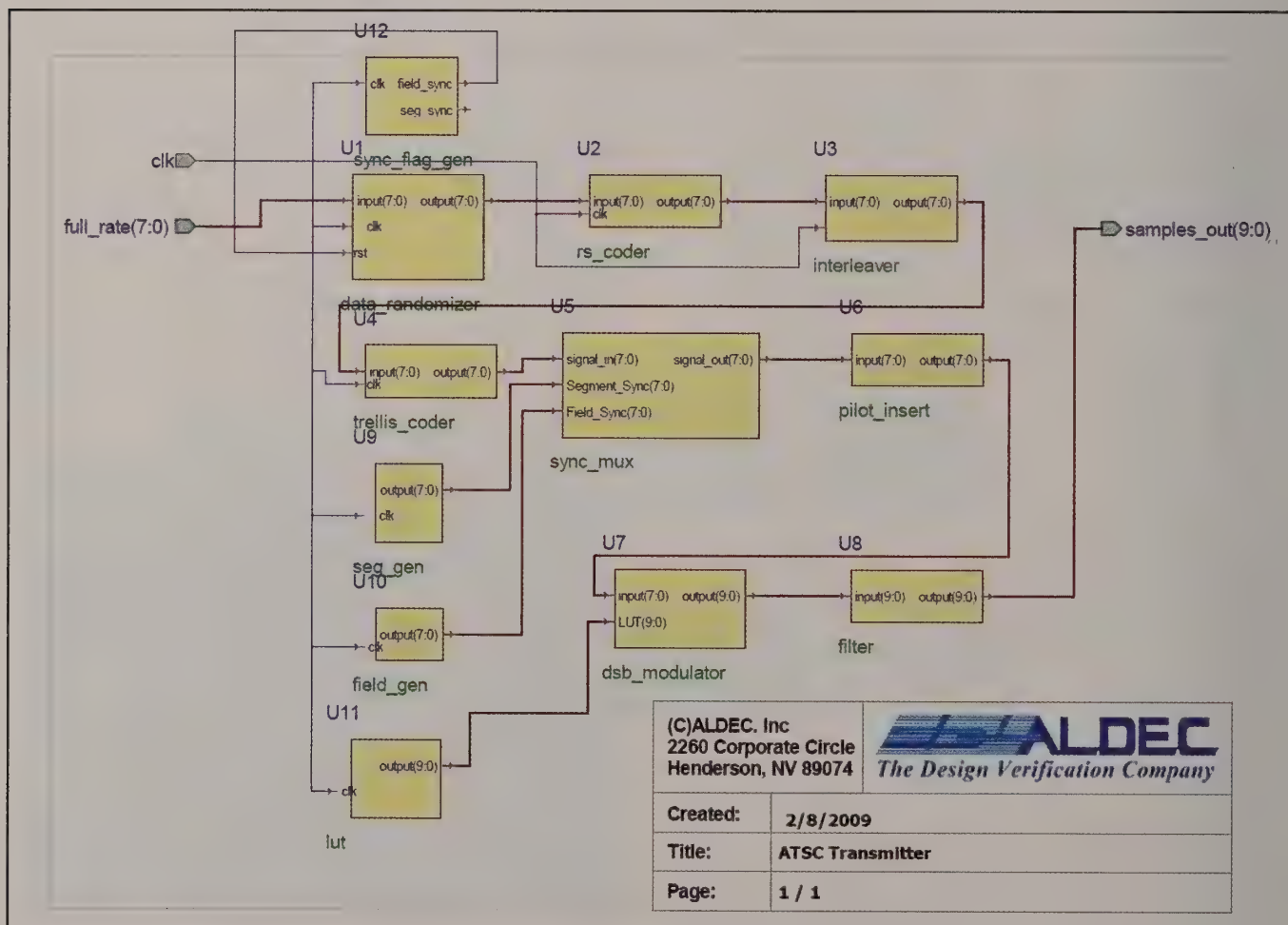


Figure 5. Designing an ATSC transmitter for the DE2 board using active HDL.

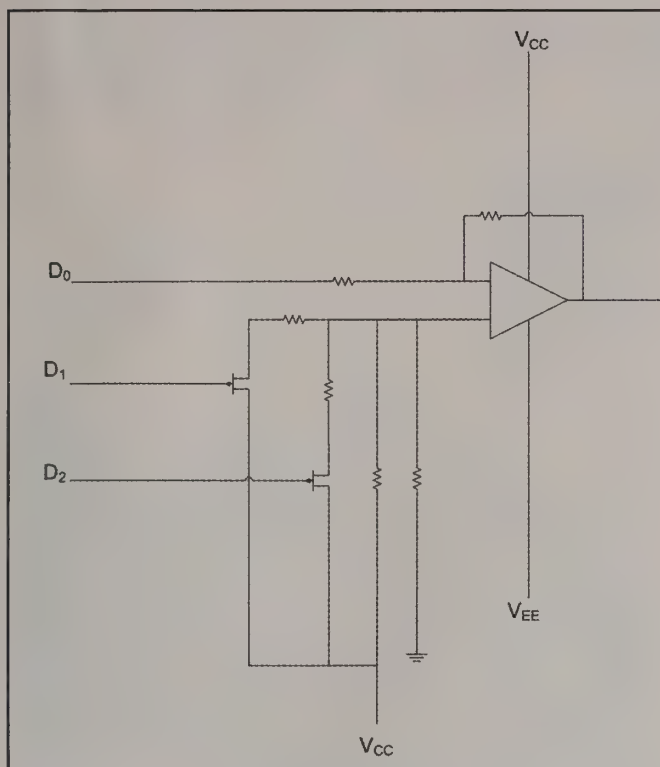


Figure 6. A simplified design for a DAC using a summing amplifier. Op-amps won't operate well at the data rate needed, so a summing amp would need to be designed with CMOS chips capable of operating fast enough.

ATSC transmitter would be a matter of programming each component that is needed to end up with the ATSC signal and then linking it together. GnuRadio, in fact, comes with many of the building blocks needed to accomplish such a task. Such an approach is limited by the processing power of the computer, the bandwidth of the USB interface, and the rate at which the video can be streamed into the computer to be processed. Taking a raw video feed and turning it into an MPEG stream is not a simple task. Combined with the other processing required, most computers would have trouble transmitting ATSC in real time.

Another approach would be to move away from a computer, but still remain entirely in the digital realm. Many of the processes involved were designed to be done in hardware rather than software, so this approach is more feasible. An FPGA³ would be a great tool to accomplish much of the processing required after an MPEG stream is acquired. Since working with FPGAs can be somewhat difficult, there are several development kits that can take away the necessary board work. The Altera DE2 board contains a JTAG programming interface as well as a video DAC which is designed for creating signals for an analog VGA monitor. I have had a fair amount of success using this DAC to create baseband radio signals. It seems to me to be entirely possible to program the DE2 board to do all the processing post MPEG compression to create a baseband RF signal. This signal could then be up-converted and amplified to create a full ATSC transmitter. To me, this approach seems to be the simplest and most practical method.

A third approach would be to use traditional modulation methods to create the 8-VSB signal. Much of the processing of the video stream would still have to be done in the digital realm,

but the modulation would not be unlike designing an ordinary AM modulator, but with a larger bandwidth. The bit stream could be mapped to the DC signal using a DAC, or a minimalist could try designing his own DAC using a summing amplifier. Such an approach would require considerably more engineering, but could result in a lower cost product.

Conclusion

D-ATV is the future of amateur television. There are many advantages that digital television offers over analog television, one of which is picture quality. It would also be a very easy leap to move from having a D-ATV station to being able to have a high-definition station. One of the more difficult components of designing a digital station is dealing with the quantity of the data and amount of computations involved in processing the video feed. This makes such a project better suited for a more hardware-oriented approach. Such a project is certainly achievable. I hope to be able to start making HD QSOs sometime in the near future!

Notes

1. While it may seem counterintuitive to randomize the data before sending it, it actually helps to reduce the amount of error that is received. Since the amount of noise that the signal will encounter during its transmission is random, the spacing and number of errors that it receives will also be random. Much like conducting random sampling for a poll across a population, we are more likely to get an accurate reconstruction of our errored signal if we rely on a random representation of the signal.

2. Trellis coding, like Reed-Solomon coding, is a method of forward error correction. The point of forward error correction is to add redundancy to the data being transmitted in order to reduce the number of errors that are received. While Reed-Solomon error correction encodes a block of data at one time, Trellis coding works with any length of code and encodes a stream of data. Trellis coding is closely related to convolutional coding, where redundancy is added to a signal by creating multiple streams from mixing the signal with different forms of time-delayed versions of itself. In ATSC, each symbol contains 3-bits (coming from the fact that we have 8-level VSB). Trellis coding works by sending differently mixed and delayed signals to each of the separate bits. This type of error correction, combined with Reed-Solomon error correction, allows us to approach very close to the theoretical limits for the amount of information that can be contained in a noisy channel.

3. An FPGA is a Field Programmable Gate Array. It is essentially a very large array of logic gates that can be programmed to perform a specific function. An FPGA is a great advancement from older technology such as masked ROM, or Programmable Logic Devices (PLDs), as they can be programmed in a much more flexible manner and are much more scalable. FPGAs can contain a very large number of gates and can be used to make up very complicated systems. They are very useful in digital signal processing and for prototyping Application Specific Integrated Circuits (ASICs). They are programmed through the use of a hardware description language such as VHDL (Very high speed integrated circuit Hardware Description Language) or Verilog.

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HOMING IN

Radio Direction Finding for Fun and Public Service

En Route to Croatia via Ohio

Did you watch the Tour de France bicycle race coverage last July? It is amazing to see the effort that all of these champions, as well as most regular weekend riders, put into optimizing their gear. Each one seeks out just the right shifters, cranks, hubs, pedals, and saddles to make up a custom cycle that is perfect for him or her.

It is the same way with hams who love on-foot hidden transmitter hunting under international rules, which is called fox-tailing, radio-orienteeing, and Amateur Radio Direction Finding (ARDF). As they progress in skill and interest, these radio athletes look for gear that is best at giving them useful bearing information without slowing them down while navigating through the forest.

Last time I told you that most radio-orienteeers start out on 2 meters with a three-element direction-finding Yagi. Elements are made from a steel measuring tape or another flexible material. These antennas are easy to construct¹ and work with any handie-talkie or scanner if you add an offset-type RF attenuator² to knock down the signal as you approach a fox transmitter.

After a few hunts, some foxtailers “graduate” to a special ARDF receiver with tone-pitch signal indication and automatic attenuation, such as Sniffer MK4 by Bryan Ackerly, VK3YNG.³ Others prefer to stick with manually operating the attenuator, because it gives them a better “feel” of the distance to the transmitter. Are these the same type of people who prefer to drive a stick-shift vehicle?

ARDF can be just a refreshing walk in the park, but winning a medal usually requires some running—lots of it if you are in a category with top-tier competitors. Therefore, your ARDF setup should be designed to be carried safely and efficiently while running. Having the antenna in one hand and the receiver in the other just won’t do. Everything should fit together in a single assembly with a handle that doesn’t require an awkward hand position. You may be carrying it for over two hours at a time, so make it comfortable.

In formal competitions, additional transceivers and GPS sets with displays are not allowed. Competitors are given an orienteeing map with standard color coding for vegetation plus symbols for trails, fences, boulders, gullies, and so forth. These maps are normally printed on 8.5" × 11" or 8.5" × 14" paper.

Many radio-orienteeers choose to cover the map with clear plastic and mount it onto a flat surface that is secured to the 2-meter Yagi. That makes it easy to see the entire map while running and to mark bearings with a crayon or grease pencil. Discarded political campaign signs printed on weatherproof corrugated material are ideal for map boards. The downside is



Vadim Afonkin, KB1RLI, finishes the 2-meter competition on the sand at the 2009 IARU Region 1 championships in Bulgaria. Like most European radiosport enthusiasts, he has a special orienteeing outfit that includes gaiters to protect his lower legs from the brush. (Photo courtesy of Vadim Afonkin, KB1RLI)

that if it is a windy day, the board turns the antenna into a sail, making it difficult to hold steady.

Champions at ARDF who are also experienced at classic orienteeing prefer to fold their maps down to about four by four inches and to “thumb” them. They hold the map in their free hand, oriented so that their direction of movement is at the top, placing the thumbnail right on top of their location. As they turn and travel, they update the map’s orientation and the thumb’s position. They may count their steps to determine how far along a trail they have progressed. Using this technique, they never lose track of their own position on the map.

What you wear is important, too. Good running shoes are a must. Orienteering tops and pants of nylon or mesh are popular among European foxtailers, because they fully cover arms and legs, yet they are cool and allow easy movement. “In Sweden, we are not allowed to run in the forest with short pants

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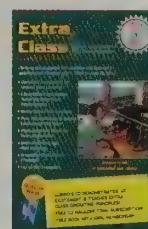
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At the 2009 USA and Region 2 ARDF Championships near Boston, Susanne Walz, DG4SFF, of Germany used this board and pushpins to keep track of her bearings and her position on the map while out on the courses. (Photo by Joe Moell, KØOV)

and short-sleeved shirts," says Per-Axel Nordwaeger, SMØBGU. "That is due to an outbreak of hepatitis, or something similar, about three decades ago."

"Nobody could figure out why only orienteers got the disease," P-A continues. "Then they noticed that many of them

ran the same paths in the forest and got scratches from trees and bushes. Doctors suspected that blood was getting on the branches and being transferred from one runner to another. We changed the clothing requirement and it solved the problem."

Carry a bottle of water with you on the course. If it will be very warm, consider a "camelback" water pouch with a hose for sipping on the run. Don't forget a granola or energy bar and a whistle, in case you need to summon help.

Earn a Trip to Opatija

Every even-numbered year, the hams of one nation invite those of all others to come to a forest to see who is best at radio-orienteering. This year, the 15th World ARDF Championships (WC) will take place near Opatija, Croatia. Over 300 competitors are expected to take to the forest courses on 2 meters and 80 meters.

Opatija is on the Bay of Kvarner on the Adriatic Sea. It is about 80 miles southwest of Zagreb, the country's capital. One-hundred miles to the west, across the Adriatic, is Venice, Italy. For over 125 years, the resort there has been a magnet for artists and other members of European high society, especially during the winter months. Composer Gustav Mahler and writer Anton Chekhov were among those who spent time in these Austrian and Hungarian villas to jump-start their creativity. Today, tourists like to visit its 14th-century Benedictine abbey, the nature park at Mount Ucka, the woods that are full of Bay Laurel, and three nearby medieval towns.

Participants will arrive in Croatia on Monday, September 13. They will be transported to the Hotel Opatija, where they will rest and prepare for the equipment testing session and opening



Vadim Afonkin, KB1RLI (left), was recognized on stage at the 2009 Region 1 championships for his efforts promoting ARDF in North America. Shaking his hand is Panayot Danev, LZ1US, representing the host country and the international ARDF Working Group. (Photo courtesy of KB1RLI)

ceremonies on Tuesday. Competition days are Wednesday and Friday, with a full day of rest and tourism on Thursday. For team members, the package cost of competitions, accommodations, food, and excursions is 320 Euros. Each person is responsible for this fee as well as for his or her transportation from home to Croatia and back.

This year's WC will follow the latest revision of radio-orienting rules, approved in September 2009 by the IARU Region 1 ARDF Working Group. New three-transmitter categories for men over age 70 and women over age 60 were added, making a total of six categories for men and five for women. Effective course lengths are now specified for each category, ranging from 6 to 12 kilometers.

The USA has had a team at every WC since 1998, and this year's team may be the biggest ever. We will be competing against countries that have had well-established ARDF programs, often government funded, since the 1960s. Russians, Ukrainians, and Czechs took home over 90 percent of the medals in 2008. On the other hand, some countries have never had medal winners, but their teams greatly enjoy participating and learning.

The USA continues to improve in the sport. Nadia Scharlau won the USA's first WC medal when she captured third place in her category on 80 meters in 2006 in Bulgaria.⁴ George Neal, KF6YKN, earned a bronze medal on 2 meters in the 2008 WC near Seoul, Korea.⁵ The USA had four top-ten category finishes that year.

Most nations select their ARDF team members by staging a national championship event. The USA has held one annually since 2001. In even-numbered years, it must take place in the spring to allow time for finalization of ARDF Team USA and preparation for WC travel in the late summer or fall.

In odd-numbered years, the championships can take place in the summer, making it possible to utilize high-altitude locations such as Lake Tahoe that are too wet or cold in the spring. Also

in odd years, the three IARU regions are encouraged to hold championships. Here in Region 2 (North and South America), only the USA and Canada have established ARDF programs at this time. The USA's national championships have been combined with IARU Region 2 Championships since 2001. Plans are in the works to have the Region 2 Championships be in Canada for the first time in 2013.

In June 2009, the USA's championships took place in a northeastern state for the first time. Vadim Afonkin, KB1RLI, set outstanding courses on both 2 meters and 80 meters in the 7000-acre Blue Hills Reservation near Boston.⁶ One quarter of the participants had never competed in a formal on-foot transmitter hunting event before, and of these, 80 percent live in eastern Massachusetts. Vadim, who learned ARDF in his native Russia as a youth, continues to promote and develop the sport in the Bay State by putting on regular practice and training sessions. His protégés will be formidable competitors at upcoming USA championships and are expected to earn positions on Team USA.

Three months after his big event in Boston, Vadim represented USA at the 2009 IARU Region 1 ARDF Championships in Ozbor, Bulgaria. He participated on the courses and in the training camp just prior. Because the USA is not a Region 1 country, Vadim had to compete as a visitor and he was ineligible for medals. However, at the medal ceremony, he was invited up to the podium and received an award for his work in developing ARDF in this part of the world. It was presented by Panayot Danev, LZ1US, who is Bulgaria's representative in the ARDF Working Group.

To Ohio in May

Stepping forward to host the 2010 USA championships are some very enthusiastic hams in the Cincinnati, Ohio area. It's no surprise that ARDF is popular in the region bounded by Interstate 275 and points north, which includes nearby parts of Kentucky and Indiana. Nowhere in the country is there a greater concentration of excellent orienteering sites with deep forest, steep hills, and networks of trails.

USA's ARDF Championships are open to all, regardless of radio-orienteering skill level or ham radio licensing status. For the second year, registration for the USA's national championships will be at no charge for first-time participants and for participants coming from outside North America. Members of ARDF Team USA will be chosen from the winners of these championships in Ohio and from the 2009 championships near Boston.

Everyone will gather on Friday, May 21 for informal practice and equipment testing at a site to be announced. That will be followed on Saturday by the formal 2-meter competition at another site with a cookout for all participants afterwards. On Sunday, the 80-meter competition will take place in yet another location, followed by the medal awards ceremony.

This year's co-chairs are Bob Frey, WA6EZV, and Dick Arnett, WB4SUV. They have trained in the area for years and traveled to the WC four times. In 2003, they put on the highly successful Third USA and Second IARU Region 2 ARDF Championships, headquartered at Miami University in Oxford, Ohio. Both of them, as well as two other organizers, want to qualify for the WC again. To make that possible, each will be setting one of the two courses and running the other.

Bob Frey, WA6EZV, and Brian DeYoung, K4BRI, will put out the 2-meter course. Dick Arnett, WB4SUV, and Matthew

Robbins, AA9YH, will be responsible for the 80-meter course. Additional assistance will come from members of the OH-KY-IN Amateur Radio Club, Orienteering Cincinnati (OCIN), and the Butler County VHF Association.

As of this writing, the exact competition sites have not been finalized, but Bob and Dick have put the following locations on the embargo list: Hueston Woods State Park, Oxford Nature Preserve, Ceasars Creek State Park, Englewood Park (Dayton), Mounds State Recreation Area (Indiana), and East Fork State Park. Anyone who will be competing in the 2010 ARDF championships may not go into these areas until then, to prevent them getting an unfair advantage of familiarity with the terrain.

As it becomes available, more information is being placed in the official website of the 2010 championships,⁷ including registration forms, local lodging information, and hunt frequencies. A pre-championship ARDF training camp on May 19 and 20 is a possibility, so look to the site for information about how to express your interest in that. Bob and Dick are also organizing the annual Foxhunting Forum at the Dayton Hamvention® one week earlier. That popular session is tentatively scheduled for Friday, May 14 at 11 AM in Room 2 of Hara Arena, although it may change to 2:45 PM.

Doppler or Beam?

Many of the questions in my incoming e-mail are about equipment selection for vehicular direction finding at VHF and UHF frequencies. Which is better, a hand-turned beam or an add-on Doppler set? Of course the answer is "It depends." For instance, when tracking a source of malicious interference, a four-element quad protruding through a hole in the car roof is not very stealthy. The four quarter-wavelength whips of a Doppler array are much easier to conceal. Before his untimely death in 2006, Mike Obermeier, K6SNE, tracked down numerous repeater jammers and bootleggers with a Doppler array mounted in the bed of his truck, covered with a non-metallic shell to make it invisible from the outside.

On the other hand, an array of quarter-wavelength whips selected one at a time has much less gain than a Yagi or quad. When the signal to be tracked is distant and weak, that's impractical. For competitive 2-meter mobile hunts, my van is equipped with a rotating quad and RF

attenuator on one receiver and a Doppler set with its array behind the quad on the roof, connected to another receiver. Usually, signals are very weak after leaving the hilltop starting point. It is not uncommon for the quad to be the only way to get bearings until I have driven about three-quarters of the way to the hidden T and the Doppler comes into range.

What about transmitter hunting in urban areas where there are many surfaces to reflect VHF/UHF signals? When

signal strength and stealth aren't overriding factors, which method is better at getting accurate bearings in these high multipath situations? That topic is of great interest to engineers at cellular and wireless companies, as well as to other commercial users of VHF/UHF.

Two researchers from the Applied Electromagnetics and Wireless Lab of Oakland University in Rochester, Michigan did an extensive study to get answers to that question. Their findings were

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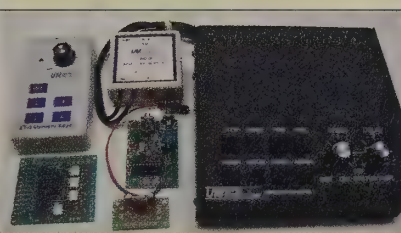
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Bob Frey, WA6EZV, will be a co-chair of the organizers for the 2010 USA ARDF Championships near Cincinnati. Here he shows his 2-meter ARDF gear to Kento Kurogi and Masahiko Mimura, the two visiting competitors from Japan, at last year's championships near Boston. He has mounted his map onto a discarded campaign sign that is taped to the elements of his Yagi antenna. (Photo by KØOV)



Dick Arnett, WB4SUV, runs the 2-meter finish corridor at the 2009 USA and IARU Region 2 ARDF Championships on his way to a gold medal in the M60 category. Dick is a co-chair of the organizers for this year's championships in Ohio. (Photo by KØOV)

detailed in a paper published by the journal *Physical Communication*.⁸ Aloï and Sharawi compared three RDF systems at 2400 MHz. Each was mounted on a vehicle inside a 195' x 213' parking garage. Bearings were taken one at a time on 488 transmitters in 122 locations inside the garage, at four heights above ground for each location. A second set of data was taken with everything the same, except that there were 46 other vehicles surrounding the car with the RDF sets.

Of course the researchers didn't have that many actual transmitters or take that many actual bearings. In fact, they didn't take any field bearings at all. They didn't even build any RDF equipment. It was all done with computer simulation. The RDF sets were represented by algorithms. The parking lot was created as a model in Wireless InSite,⁹ a commercial software package. That program traces many signal-ray paths between each transmitter and receiver, including reflected paths via surfaces of the parking lot and the other cars. The parking-lot model was quite detailed, including concrete, glass, rubber and metal in the floor, ceiling, support posts, and the other cars.

The first method to be simulated was amplitude-based, analogous to RDF with a Yagi or quad. The researchers wrote pseudo-code for an automated system with eight directional dual-polarization antennas, each covering a 45-degree segment of azimuth. Received power levels from the antennas were calculated and then compared to determine the signal bearings. Two possible half-power beamwidths for each antenna were simulated, 45 degrees and 90 degrees.

The second system was a classic sequentially-switched Doppler set with a circle of zero-gain vertical antennas, switched sequentially into the receiver. That switching imparts a FM com-

ponent to the incoming signal at the fixed frequency of the pseudo-rotation. The relative phase of that added modulation is a function of the direction of arrival of the incoming signal.

The third RDF system was described as "digital PLL." It had the same set of vertical antennas in a circle, but the relative signal phase at each whip was measured by a bank of phase-locked loops. That information was compared against a table of the expected relative phases that had been calculated for each whip at all azimuth directions. The perceived bearing was the direction of arrival for which the table values produced the best fit for the target phase information. This is analogous to a multi-element time-difference-of-arrival (TDOA) RDF system.

Some of the study conclusions seem obvious. Any experienced hidden-transmitter hunter could have predicted them. For instance, a RDF antenna on top of the car roof worked better than one underneath it. Narrow (45-degree beamwidth) directional antennas gave better accuracy than wide (90-degree beamwidth) antennas in the amplitude-based system. Accuracy of each method was better with no other cars nearby than it was when surrounded by cars. Bearings were better when the transmitters were 70 inches above ground, compared to lower locations. No surprises there.

The big question was which of these RDF methods was most accurate in high multipath. To determine this, the researchers compared target azimuth as perceived by the simulated RDF sets (the bearings) with the actual target azimuth. If the bearing was within plus or minus 22.5 degrees of being correct, the data point was judged as a PASS. If the bearing was off by more than that, it was judged as a FAIL.

The amplitude-based method won the contest handily. Pass

rates for the 45-degree beamwidth car-top-mounted receive antenna in the garage were between 65 and 89 percent. Equivalent pass rates for the better Doppler (8 elements) were only 10 to 20 percent. The eight-element TDOA system was only slightly better than the Doppler, with pass rates ranging from 15 to 24 percent.

This simulation assumed an "ideal" Doppler RDF system, which is probably better than the Doppler you are using for transmitter hunting. Many hams have antenna sets with non-optimum antenna RF switches, which creates an undesired amplitude response that degrades the bearing accuracy.¹⁰ Antenna position on the vehicle can have a significant effect on accuracy, too.

A 10- to 20-percent probability of bearings within 22.5 degrees of being correct makes the Doppler technique seem almost not worthy of consideration. However, these researchers did not test the method that hams use to compensate for the basic inaccuracies of fixed-location Dopplers: Increase the effective baseline by taking readings from multiple places.

Hams with Doppler experience know that bearings from their sets at fixed locations are always suspect due to multipath, so they keep their Doppler-equipped vehicles in motion whenever possible. They average the bearings obtained from many points along the road, either with computer assistance or just by eyeballing the display. That goes a long way toward improving Doppler RDF accuracy and making it on par with beams and other amplitude-based techniques for VHF/UHF mobile transmitter hunts.

I have two suggestions for future research with these models:

1. Acquire a set of data with the RDF-equipped cars moving along a track within the parking garage, taking multiple bearings and averaging. That would quantify the improvement that can be obtained by increasing the effective baseline.

2. Bearings that are in error by 22 degrees do not give useful results when triangulated, so acquire additional data sets with pass criteria of plus or minus ten degrees error and five degrees error. That will provide an even better comparison of the three RDF methods in high multipath.

Many thanks to all of the *CQ VHF* readers who have sent in their stories, questions, and ideas for future column topics. Whether you prefer vehicular "T-hunts"

or all-on-foot foxhunts, make 2010 your year to get more involved in ham radio direction-finding activities. Encourage other hams to do so also. Then let me know what is happening in your area so I can pass it along to other readers.

73, Joe, KØOV

Notes

1. <http://www.homingin.com/equipment.html>
2. <http://www.homingin.com/joeK0ov/offatten.html>
3. <http://www.foxhunt.com.au/>
4. <http://www.homingin.com/bulgaria.html>
5. <http://www.homingin.com/korea08.html>
6. The story of these championships is in my "Homing In" column for Summer 2009 entitled "Championship Foxhunting Brings the World to Boston."
7. <http://www.usardf2010.com/>
8. D.N. Aloï, M.S. Sharawi, "Comparative analysis of single-channel direction finding algorithms for automotive applications at 2400 MHz in a complex reflecting environment," *Physical Communication* (2009), doi:10.1016/j.phycom.2009.08.002
9. <http://www.remcom.com/wireless-insite>
10. More information on Doppler RDF sets and how to optimize them is in my "Homing In" column for Spring 2004 entitled "Get Better Performance From Your Doppler Set."



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Stacking Yagis

I would like to start out with a bit of an apology to the readers of both *CQ VHF* and *CQ*. I try to avoid the having the same topic in my columns in both magazines, but stacking Yagis has been a hot topic of late. Nothing seems to get a group of VHFers to take off in a dozen different directions than a discussion on how far apart you need to space your 50-, 144-, 222-, and 432-MHz Yagis to minimize interaction. Also, I can go into a bit more detail here than I could in *CQ*.

First we start with a concept that will make university professors cringe, but it

works quite well for our applications. The subject is capture area.

Think of capture area like you would a panel of solar cells. If you want twice as much power from a solar panel, or 3 dB more DC power, you need twice as much area. In this case we will call it capture area. An antenna with 3 dB more gain will also have twice as much capture area.

In figure 1 are two identical antennas. While I drew the capture area as a line, in reality it is a tapered area with very fuzzy boundaries. You want to stack the antennas at a distance where their capture areas overlap just a bit. A little more overlap and you have a cleaner pattern and less losses in the phasing harness. Farther apart and you get a little bit more gain, but more masts and longer phasing lines are needed, and in the end you lose most of that extra gain. Also, for those of us with EME arrays, stacking for optimum suppression of side lobes is taking this exercise to an entirely new level.

In figure 2 I chose a 144-MHz and a 432-MHz Yagi. Of course, any two bands could be used, and a higher gain Yagi would have a larger circle. To prevent

interaction between the two antennas we need to stack them as shown in figure 3, right? No, because we have to consider the capture area of the Yagis on the same frequency at the same time. In figure 4 you can see how the capture area of the 144-MHz Yagi is very small at 432 MHz, and the 144-MHz capture area of the 432-MHz Yagi is next to nothing. This means we can safely stack the antennas much closer together. Just think of some of the VHF rover stations with over a dozen antennas on their roof racks.

At the 2009 Microwave Update conference I had an opportunity to run some quick tests on the antenna range. While measuring a 432-MHz beam, 50-ohm terminated 902-MHz and 1296-MHz Yagis were mounted at different heights as shown in photo A. At spacings as close as 6 inches the gain change was only a few tenths of a dB at 432 MHz. I had to space them where the U-bolts were actually touching before the gain dropped a full dB. Also, I think much of that was SWR losses where the elements from the other Yagi got close to the 432's driven element. After all, on HF it is quite com-

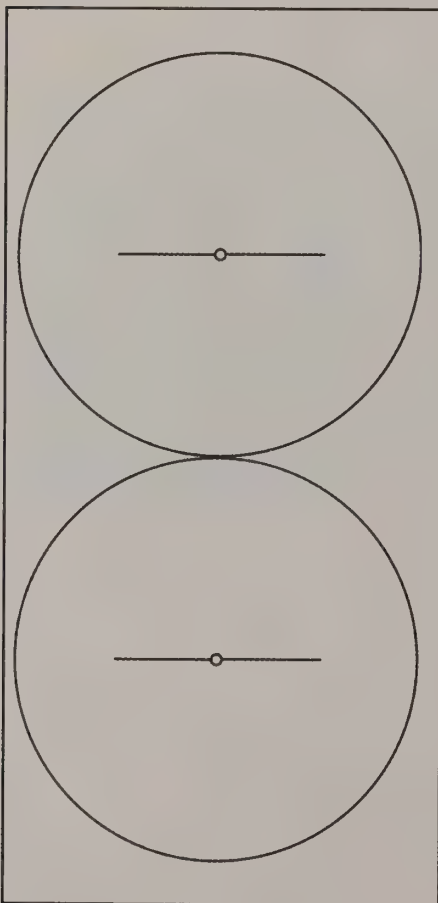


Figure 1. Capture area of two Yagis stacked for maximum gain.

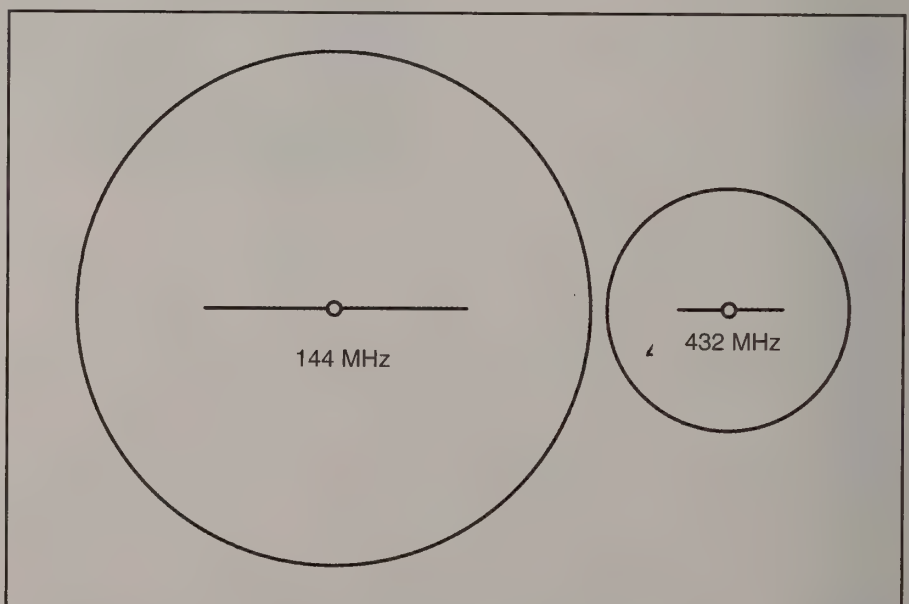


Figure 2. Relative capture area of Yagis for different bands.

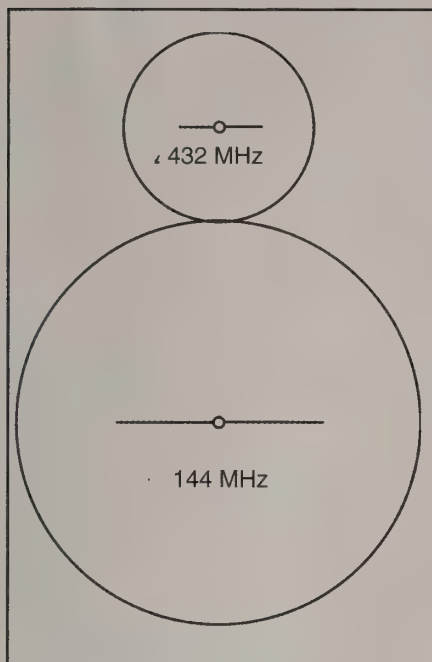


Figure 3. The stacking distance for dissimilar Yagis.

mon to build Yagis for two, three, and even five bands on the same boom.

The bottom line is that you can mount a higher band Yagi very close to a lower frequency Yagi with virtually no interaction. The next question is what changes are there in the higher band Yagi? Well, with snow coming down as I write this column, it will take warmer weather to make those measurements. However, I'm just a curious as you are, so stand by.

Pitfalls in Helix Antenna Construction

Without a doubt, the UHF+ antenna with the most myths is the helix. Dozens of websites have simple calculations for determining the dimensions for your desired frequency. There is a problem, though. The calculations themselves come out about 3 dB too high. However, few hams actually build the helix per the assumptions behind those calculations.

The helix in photo B looks good, but it doesn't work. I'll be going into the assumptions and construction pitfalls next time.

Letters, Letters, We Get Letters

From Mark, we have some questions concerning recent advertisements about "low-noise" VHF antennas. An antenna picks up all signals, both the signal you

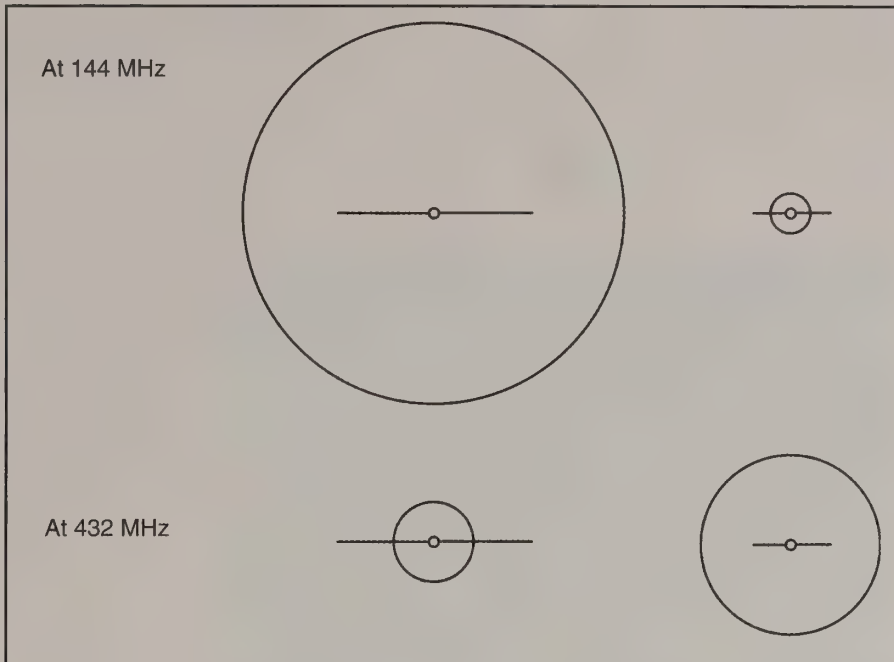


Figure 4. Relative capture area of the Yagis on the same frequency.

want and the signals you don't want. Below 2 MHz there are antenna designs that do a good job of picking up skywaves better than local noise and they are called low-noise antennas, but that is not the case with Yagis.

In figure 5 I have plots from two versions of a Cheap Yagi. Note that one has much smaller back lobes than the other.

When it comes to extreme communications such as moonbounce, any signal coming in from the back of the antenna is just system noise. In this case low noise means very low side and back lobes. For ragchewing or repeater service you would never hear any difference. Thus, low noise is another way of saying the Yagi has a very clean pattern.



Photo A. Testing dissimilar Yagis at different spacings.

It's one thing to have a "Mickey Mouse" antenna, and it's another thing to have an antenna with Mickey Mouse printed on it. At the Microwave Update 2009 conference we had the antenna ranges set up. Photo C shows here Doug, KA2UPW/5, with his combination L-

Band/S-Band collapsible dish based on a Disneyland folding parasol. Not bad—just over 16 dBi gain on both 1269 MHz and 2402 MHz.

questions and topic suggestions. Just drop a note to my QRZ.com snail-mail address or an e-mail to <wa5vjb@cq-amateur-radio.com>. For other antenna articles and projects, you are welcome to visit <www.wa5vjb.com>.

73, Kent, WA5VJB

Again, we welcome your antenna



Photo B. Pitfalls when constructing helix antennas.

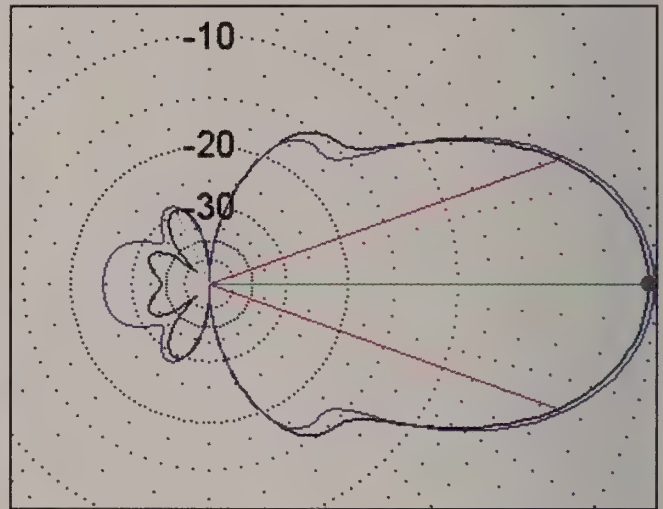


Figure 5. Low back lobes and low noise.

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Photo C. Mickey Mouse L-Band/S-Band collapsible dish.

FM

FM/Repeaters—Inside Amateur Radio's "Utility" Mode

Repeaters: Open or Closed?

The FCC recently reaffirmed the legitimacy of *closed repeaters* by dismissing a petition to modify Part 97 of the FCC rules to eliminate closed repeaters. In this column, we'll take a look at this controversial issue and try to explain the FCC's actions.

What is a Closed Repeater?

The ARRL website (www.arrl.org) gives us this simple definition: Closed repeater—a repeater whose access is limited to a select group.

Sometimes called a *private repeater*, a *closed repeater* is intended to be used only by a specific group of radio amateurs. How this exclusivity is enforced varies, but usually includes a strong dose of social pressure. In other words, if you show up on a closed repeater you are likely to be verbally encouraged to find another repeater. (The amount of politeness in the delivery of this message tends to vary dramatically!) Closed repeaters may also employ some technical methods to keep unwanted users out, including various forms of tone access (CTCSS, DTMF, DCS, etc.). However, keep in mind that the use of tone access does not necessarily mean the repeater is closed. Years ago, the use of CTCSS was often associated with closed repeaters, but these days many open repeaters use tone access to avoid a variety of interference problems.

For closed repeaters that are supported by a formal organization, repeater usage is usually limited to club members only. Membership eligibility may be tightly controlled (such as requiring sponsorship by current club members), or it may just require an application with payment of dues. Another common model for a closed repeater is for a few individuals to collaborate on putting up a repeater and make it available to only their social group. In this case, being "in the group" can be very informal.

There are varying degrees of "closed" when it comes to repeaters. For example, many open repeaters choose to keep spe-

cial features such as autopatch operation or repeater linking restricted to members only. Some closed systems will go ahead and operate "open" during an emergency situation. Some closed repeater groups are open to adding new members to help support the cost of the repeater system, while other groups prefer to limit membership to the core group.

Why Closed Repeaters?

There are a number of reasons why groups or individuals decide to make their repeater systems closed. The most common reason seems to be the idea of keeping particular types of individuals and operating styles off the repeater. One closed repeater system states this clearly on its website with the motto "no scum bags." If you dig deeper into this, you may find that these repeater licensees have had trouble in the past with certain repeater users spoiling the use of the repeater for the larger group. Ham repeaters are more than just pieces of radio gear on a hill; they have a social aspect to them. Over time, groups that hang out on a repeater tend to develop acceptable patterns of radio operation *for that repeater*. Like-minded operators are attracted to the same repeater systems and tend to have compatible operating habits.

Some repeaters sit quiet all day long except for a few short calls and a scheduled net or two. Others are known as ragchew machines and get a lot more use. Some systems are dedicated to specific ham interests such as ARES, RACES, DX, etc. In most regions, a new ham gradually figures out the personalities of these repeater social groups and migrates to one they find to be comfortable. Now imagine some of the ragchew-oriented folks getting on a repeater that has users who prefer a quiet channel and you can see some conflict. If that's not enough, toss in some diversity of political and social views and it can get ugly. With a closed repeater, the group attempts to actively control who is allowed on the repeater and keep things operating the way they prefer.

Another reason for closed repeaters is the *financial support* argument. Re-

peaters are expensive and require significant time and money to keep them functional. Some repeater owners get very frustrated when a few users hog the machine while not contributing any financial support. Pull out the club roster for your local repeater group and compare it to the callsigns you hear every day on the repeater. You may be surprised at how many regular users don't pay dues to support the repeater. Requiring a paid-up club membership to use the machine is one solution to that problem.

Another argument for keeping a repeater closed is because there are *complex features* on the system. Consider a group that puts up a repeater system that has many options for linking together different channels and repeaters. They may conclude that the users need to be trained to use the system and decide to limit access to carefully selected hams who have the competency to operate the system. This training requirement (and perhaps membership requirement) results in a closed system.

Supporting these arguments for having a closed repeater is the underlying principle of *private property*. The repeater owner thinks, "This repeater is my amateur radio station and I decide who has access to this equipment." Nowhere in the FCC rules does it say an amateur operator has to allow everyone use of his station.

Arguments Against Closed Repeaters

Many people argue against allowing closed repeaters from simply a fairness point of view. Locking people out of a repeater is discrimination and just seems like the wrong thing to do in this friendly hobby of amateur radio. Sometimes this is articulated as being inconsistent with *good amateur practice* (Part 97.101a).

A more specific argument is found in Part 97.101(b), which says:

Each station licensee and each control operator must cooperate in selecting transmitting channels and in making the most effective use of the amateur service frequencies. No frequency will be assigned for the exclusive use of any station.

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e-mail: <bob@k0nr.com>

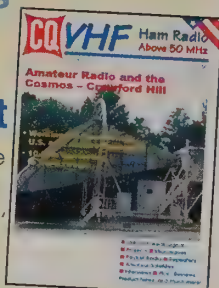
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In other words, licensed amateur radio operators can use any frequency (within their license privileges). Therefore, they should be able to use any repeater.

Conventional FM repeater technology is not frequency agile. A repeater owner sets up a repeater to function on a specific pair of input/output frequencies, tunes the transmitter, receiver, and duplexer to operate on that pair, and it stays there. This creates a direct correspondence between a particular amateur radio station (the repeater) and a specific frequency (actually a pair of frequencies). The FCC actively encourages repeater owners to work with their local frequency coordinator to select a frequency pair that is not already in use, with the expectation that the frequency coordinator will not coordinate another repeater on the same frequency in the same general location. Most ham radio activity isn't tied to one frequency; if the frequency I want to use is busy, I just turn the dial and find another one, just as good as the first one. Thus, the *shared frequency* argument is that a coordinated closed repeater is essentially assigned a frequency for the exclusive use of a particular group of sta-

§97.205 Repeater station.

(a) Any amateur station licensed to a holder of a Technician, General, Advanced or Amateur Extra Class operator license may be a repeater. A holder of a Technician, General, Advanced or Amateur Extra Class operator license may be the control operator of a repeater, subject to the privileges of the class of operator license held.

(b) A repeater may receive and retransmit only on the 10 m and shorter wavelength frequency bands except the 28.0–29.5 MHz, 50.0–51.0 MHz, 144.0–144.5 MHz, 145.5–146.0 MHz, 222.00–222.15 MHz, 431.0–433.0 MHz and 435.0–438.0 MHz segments.

(c) Where the transmissions of a repeater cause harmful interference to another repeater, the two station licensees are equally and fully responsible for resolving the interference unless the operation of one station is recommended by a frequency coordinator and the operation of the other station is not. In that case, the licensee of the non-coordinated repeater has primary responsibility to resolve the interference.

(d) A repeater may be automatically controlled.

(e) Ancillary functions of a repeater that are available to users on the input channel are not considered remotely controlled functions of the station. Limiting the use of a repeater to only certain user stations is permissible.

(f) [Reserved]

(g) The control operator of a repeater that retransmits inadvertently communications that violate the rules in this Part is not accountable for the violative communications.

FCC Rules Specific to Repeaters

(h) The provisions of this paragraph do not apply to repeaters that transmit on the 1.2 cm or shorter wavelength bands. Before establishing a repeater within 16 km (10 miles) of the Arecibo Observatory or before changing the transmitting frequency, transmitter power, antenna height or directivity of an existing repeater, the station licensee must give written notification thereof to the Interference Office, Arecibo Observatory, HC3 Box 53995, Arecibo, Puerto Rico 00612, in writing or electronically, of the technical parameters of the proposal. Licensees who choose to transmit information electronically should e-mail to: prcz@naic.edu.

1. The notification shall state the geographical coordinates of the antenna (NAD-83 datum), antenna height above mean sea level (AMSL), antenna center of radiation above ground level (AGL), antenna directivity and gain, proposed frequency and FCC Rule Part, type of emission, effective radiated power, and whether the proposed use is itinerant. Licensees may wish to consult interference guidelines provided by Cornell University.

2. If an objection to the proposed operation is received by the FCC from the Arecibo Observatory, Arecibo, Puerto Rico, within 20 days from the date of notification, the FCC will consider all aspects of the problem and take whatever action is deemed appropriate. The licensee will be required to make reasonable efforts in order to resolve or mitigate any potential interference problem with the Arecibo Observatory.

tions. This seems inconsistent with Part 97.101(b).

The FCC Decision

The recent petition submitted by Murray Green, K3BEQ, used the *shared frequency* argument against allowing closed repeaters. According to the FCC dismissal letter, the petition requested "...that the Commission amend Section 97.205(e) of its Rules to prohibit a repeater station licensee or control operator from limiting the use of a repeater to only certain user stations, unless a user blatantly violates the Commission's Rules." The FCC rejected the argument, saying, "Coordination does not and cannot result in assignment or establish control of an amateur service channel, and nothing in the rules prohibits other amateur stations from using the channels for which a repeater has been coordinated when they are not being used by the repeater."

Now that is a rather odd statement by the FCC, since generally accepted operating practice is to *not* transmit on the input or output frequency of a repeater unless you are intending to use that repeater. Operating simplex on the input or output of a repeater is highly likely to create interference with users of that repeater.

More importantly, the FCC upheld the principle that the repeater licensee or control operator is responsible for the proper operation of the repeater. The dismissal letter says, "Section 97.205(e) merely enables a repeater licensee or control operator to control the repeater, so that he or she can ensure the repeater is properly operated as required by Section 97.105(a)." In other words, limiting the use of the repeater to only certain user stations is an important tool for ensuring the repeater is operating in compliance with FCC rules.

This is very consistent with FCC enforcement actions over the last decade.

QUARTERLY CALENDAR OF EVENTS

Take a look at the warning letters on the FCC Amateur Radio enforcement page. They include multiple letters to amateur radio operators who have been told to stay off a particular repeater. Included in the typical FCC letter is this statement:

The Commission requires that repeaters be under the supervision of a control operator and not only expects, but requires, that such control operators be responsible for the proper operation of the repeater system. Control operators may take whatever steps they deem appropriate to ensure compliance with the repeater rules, including limiting the repeater use to certain users, converting the repeater to a closed repeater or taking it off the air entirely.

Clearly, the Commission has chosen to back the repeater licensees and control operators even to the extent of excluding users from a repeater. While this can result in dictatorial behavior by a repeater owner, to not support this principle opens the door to repeater owners not being able to effectively control their systems. One ham told me once, "In the limit, all repeaters are closed, because you as a repeater licensee must be able to exclude certain operators to protect your license."

What does this decision mean for the average repeater user? Not much. Let's face it: Our main problem is not being excluded from repeater systems. A much bigger issue is that there are lots of excellent repeaters on lots of channels, available but hardly ever used. If you find yourself locked out of a closed repeater, there is likely another one around that will meet your needs. So look around and find the repeater group that fits your operating style. You'll be a lot happier and so will the users of the closed repeaters.

Tnx and 73

Thanks for taking the time to read another one of my columns on the "Utility Mode." Closed repeaters are controversial and I have tried to treat the topic in a balanced and factual manner. This article is completely my opinion and does not necessarily reflect the views of *CQ VHF* management and staff. I always enjoy hearing from readers, so drop me an e-mail with your thoughts. 73, Bob, KØNR

References

ARRL Repeater Glossary: <<http://www.arrl.org/tis/info/pdf/rep gloss.pdf>>

FCC Letter Dismissing the K3BEQ Petition: <http://hraunfoss.fcc.gov/edocs_public/attachmatch/DA-09-2559A1.pdf>

FCC Amateur Radio Enforcement Page: <<http://www.fcc.gov/eb/AmateurActions/Welcome.html>>

Current Contests

The European Worldwide EME Contest 2010: Sponsored by DUBUS and REF. The EU WW EME contest is intended to encourage worldwide activity on moonbounce. See: <<http://www.marsport.org.uk/dubus/EMECContest2010.pdf>>.

Spring Sprints: These short-duration (usually four hours) VHF+ contests are held on various dates (for each band) during the months of April and May. See N6CL's VHF Plus column in *CQ* magazine for a future announcement.

The 2 GHz and Up World Wide Club Contest: Sponsored by the San Bernardino Microwave Society, this contest runs the second weekend of May. Rules are at: <http://www.ham-radio.com/sbms/club_test/2ghz_up_test.html>.

Conference and Convention

Southeast VHF Society: The 14th annual conference will be hosted in Morehead, KY, April 22–24. For information go to: <<http://www.svhfs.org/>>.

Dayton HamVention®: This will be held as usual at the Hara Arena in Dayton, Ohio May 14–16. Go to: <<http://www.hamvention.org>>.

Calls for Papers

Calls for papers are issued in advance of forthcoming conferences either for presenters to be speakers, or for papers to be published in the conferences' *Proceedings*, or both. The following organizations and/or conference organizers have announced calls for papers:

Southeastern VHF Society Conference: Technical papers are solicited for the 14th annual Southeastern VHF Society Conference to be held in Morehead, KY on April 23–24. Papers and presentations are solicited on both the technical and operational aspects of VHF, UHF, and Microwave weak signal amateur radio.

The deadline for the submission of papers and presentations is February 5, 2010. All submissions should be in Microsoft Word (.doc) or alternatively Adobe Acrobat (.pdf) files. All text, drawings, photos, etc. should be black and white only (no color). Submissions for presentation at the conference should be in PowerPoint (.ppt) format, and delivered on either a USB memory stick or CDROM or posted for download on a website of your choice.

Please indicate when you submit your paper or presentation if you plan to attend the conference and present there or if you are submitting just for publication. Papers and presentations will be published in the conference *Proceedings*. Send all questions, comments, and submissions to the program chair, Robin Midgett, K4IDC, via <K4IDC@comcast.net>. For further information about the conference go to: <<http://www.svhfs.org>>.

Central States VHF Society Conference: Technical papers are solicited for the 44th annual Central States VHF Society Conference to be held in St. Louis, MO on July 22–24. Papers, presentations, and posters on all aspects of weak-signal VHF and above amateur radio are requested. Please contact the folks below if you have any questions about the suitability of a topic. Strong editorial preference will be given to those papers that are written and formatted specifically for publication, rather than as visual presentation aids. Submissions may be made via the following: electronic formats (preferred) via e-mail; uploaded to a website for subsequent downloading; on media (3.5" floppy, CD, USB stick/thumb drive). Deadline for submissions: May 1. For more information, contact CSVHFS President Ron Ocho, KOØZ, at <ko0z@arrl.net>.

Quarterly Calendar

The following is a list of important dates for EME enthusiasts:

Feb. 5	Moon last quarter.
Feb. 7	Poor EME conditions.
Feb. 13	Moon apogee.
Feb. 14	New Moon. Poor EME conditions.
Feb. 21	Moderate EME conditions.
Feb. 22	First quarter Moon.
Feb. 27	Moon perigee.
Feb. 28	Full Moon. Excellent EME conditions.
Mar. 7	Last quarter Moon.
Mar. 7	Very poor EME conditions.
Mar. 12	Moon apogee.
Mar. 14	Moderate EME conditions.
Mar. 15	New Moon.
Mar. 20	Spring equinox.
Mar. 21	Moderate EME conditions.
Mar. 23	First quarter Moon.
Mar. 28	Moon perigee. Excellent EME conditions.
Mar. 30	Full Moon.
Apr. 4	Poor EME conditions.
Apr. 6	Last quarter Moon.
Apr. 9	Moon apogee.
Apr. 11	Moderate EME conditions.
Apr. 14	New Moon.
Apr. 18	Poor EME conditions.
Apr. 21	First quarter Moon. <i>Lyrids</i> meteor shower.
Apr. 24	Moon perigee.
Apr. 25	Very good EME conditions.
Apr. 28	Full Moon.
May 2	Very poor EME conditions.
May 5	Eta Aquarids meteor shower.
May 6	Moon apogee. Last quarter Moon.
May 9	Moderate EME conditions.
May 14	New Moon.
May 16	Poor EME conditions.
May 20	Moon perigee. First quarter Moon.
May 23	Good EME conditions.
May 27	Full Moon.
May 30	Very poor EME conditions.
June 3	Moon apogee.
June 4	Last quarter Moon.
June 6	Moderate EME conditions.
June 12	New Moon.
June 13	Poor EME conditions.
June 15	Moon perigee.
June 19	First quarter Moon.
June 20	Moderate EME conditions.
June 26	Full Moon.
June 27	Very poor EME conditions.
July 1	Moon apogee.

—EME conditions courtesy W5LUU

Meteor Showers

The α -Centaurids meteor shower is expected to peak on February 8 at 0530 UTC. The γ -Normids shower is expected to peak on March 14. Other February and March minor showers include the following and their possible radio peaks: *Capricornids/Sagittarids*, February 1, 1500 UTC; and χ -*Capricornids*, February 13, 1600 UTC.

The *Lyrids* meteor shower is active during April 16–25. It is predicted to peak around 2200 UTC on the 22. This is a north-south shower, producing at its peak around 10–15 meteors per hour, with the possibility of upwards of 90 per hour.

A minor shower and its predicted peak is *n-Puppids* (peak on April 23, at 2200 UTC). Other April, May, and June minor showers include the following and their possible radio peaks: April *Piscids*, April 20, 1500 UTC; δ -*Piscids*, April 24, 1500 UTC; *E-Arietids*, May 9, 1400 UTC; May *Arietids*, May 16, 1500 UTC; and *o-Cetids*, May 20, 1400 UTC. June *Arietids*, June 7, 1700 UTC; *zeta-Perseids*, June 9, 1700 UTC; and β -*Taurids*, June 28, 1600 UTC.

For more information on the above meteor shower predictions please see Tomas Hood, NW7US's propagation column beginning on page 71 as well as the International Meteor Organization's website: <<http://www.imo.net>>.

EMERGENCY COMMUNICATIONS

The Role of VHF in EmComm

EmComm – Then and Now

I have been an amateur radio operator for over forty years and have seen the many changes our hobby has gone through. Many of those changes have been for the better, but some came with a certain amount of aggravation. It seems that change is hard for most of us “old timers” but more readily accepted by younger hams.

Prior to 9/11, if there was an emergency your local government agencies would be clamoring for the assistance of local hams. We would merely arrive on site and

be assigned a communications task, even if we were just as a backup for their communications. I remember as a kid seeing a mobile emergency setup of a local ham. It consisted of a Swan 500C and power supply with a trunk full of radios, cables, antennas, and parts—all stuffed neatly in a Studebaker. Now a ham can fit almost the same capabilities into a backpack.

Just prior to 9/11 our state (Washington State) and counties demanded that all emergency volunteers have an emergency volunteer card. This card protects the state in the event that a volunteer was hurt while assisting in an emergency by giving him/her medical insurance for that time period. I am sure that many other

states are requiring this as well. In today’s post-9/11 era many organizations also require training that is given for free by the Federal Emergency Management Agency (FEMA). Some organizations may require background checks or additional training provided by the ARRL.

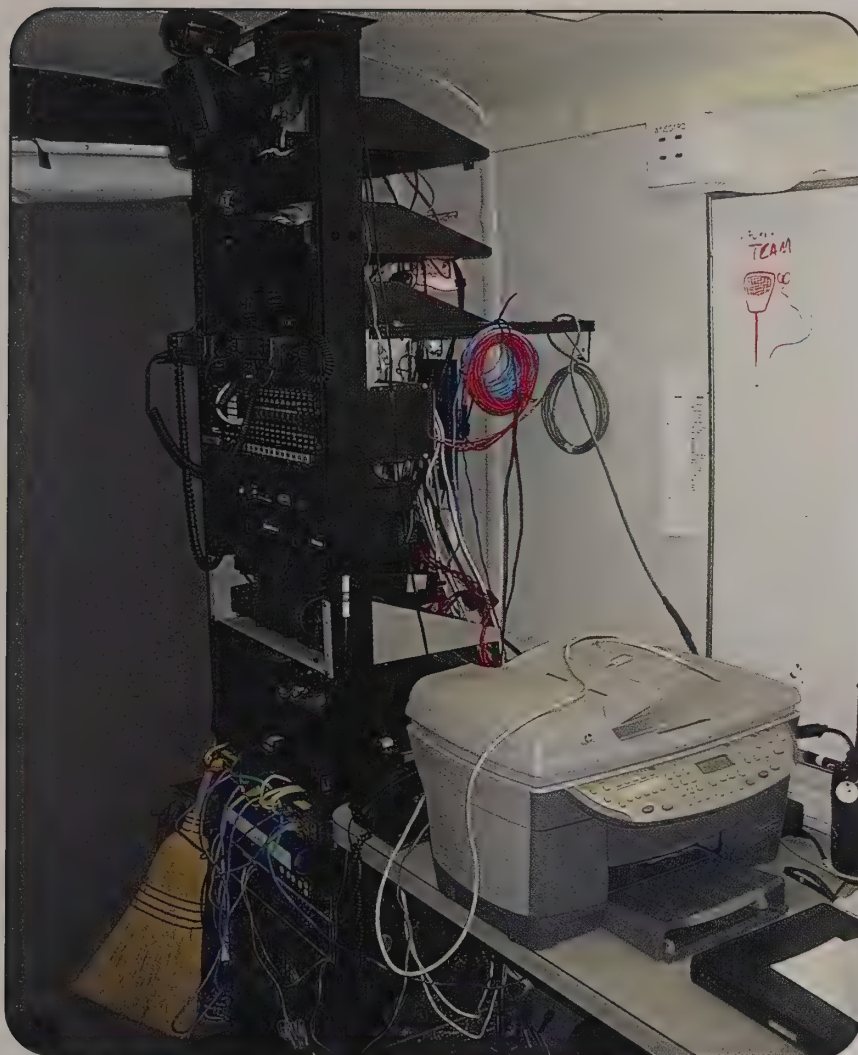
The real question is whether all this training is necessary in order to assist our fellow man.

I can only speak from my personal experience. As a member of the Washington National Guard and the Subject Matter Expert (SME) in emergency communications, I was asked to be a member of the first team from our state to fly to New Orleans after Hurricane Katrina.

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This is the team that brought the first air-to-ground communications into New Orleans after Hurricane Katrina. The author is in the first row second from the left.



A communications van brought in by another state to assist in communications.

Our mission was to set up communications for the operations center in order to control the air traffic in and around the city. When we arrived, there was no control system in place; several close calls between military and civilian helicopters made the success of our mission imperative. We arrived about 1:00 AM, and even though we were tired from the long flight, we managed to complete this task before the sun rose. As soon as we were up and running, we began our 12-hour shifts to monitor and assist. During our time off there was very little to do, and being a ham with a "Go-Kit" (which I had stuffed in my duffle bag), I set up my "shack" in the hallway beside my cot. My equipment consisted of a Yaesu FT-817 and a dipole taped to an A10 that was in for maintenance before the hurricane hit.

My first attempt was to try all of the repeaters that I had pre-programmed before arriving in the area. No luck, as

most, if not all, had been damaged or destroyed. The one I did finally hit was deathly silent during the entire month that I was there. As for the HF bands, I have to admit that my antenna was located on a metal aircraft in an all-metal hanger about eight feet off the ground. I was lucky if I could hear down the runway, let alone anywhere else.

I did meet up with another ham who was an officer in the Louisiana National Guard. He shared with me how frustrated he was that they were denying entry into the New Orleans area to ham radio operators who had not been requested or who did not have the required training/background check. After returning to the state of Washington, I heard that this had occurred more often than not, even though amateur radio was touted for its support during Katrina. Today, five years later, there is a bill in the Senate seeking to have the Department of Homeland

New Name for MARS

The former Military Affiliate Radio System has been re-christened as the Military Auxiliary Radio System and has been charged with a new mission in the area of Homeland Security. Bruce Tennant, K6PZW, has the details:

"Yes, MARS does have a new mission. On Wednesday, December 23, the Department of Defense issued an official Instruction concerning MARS that is effective immediately. This Instruction gives the three MARS services—Army, Air Force, and Navy/Marine Corps—a new focus and their first major revision since January 26, 1988.

"In the past, MARS had focused primarily on emergency communications and health and welfare support. The DoD's Instruction now directs the three MARS services to provide contingency radio communications to support US government operations, Department of Defense components, and civil authorities at all levels.

"MARS units will still continue to provide health and welfare communications support to military members, civilian employees, and other designated groups when in remote or isolated areas, in contingencies, or whenever appropriate. However, MARS must also be capable of operation in radio only modes without telephone service or access to the Internet. Also, it must be sustainable on emergency power when public utility power has failed. Also, some MARS stations must be transportable for timely deployment." — AR Newsline, 1/1/10

Security look at how amateur radio can be used to support its mission.

So here is the good and the bad. I am in total agreement that training should be required for every ham who desires to work in emergency communications at an actual disaster site. Let me be clear that this training is only required if you desire to work at the site itself. Most, if not all, organizations now require NIMS training. NIMS stands for the National Incident Management Structure, and the associated training covers all aspects of responding to an emergency. One of the most important concepts is in understanding the Incident Command Structure (ICS). In order to operate in today's ICS environment you need to know who the Incident Commander is and understand the roles of those below him or her.

Those hams who want to provide support from their home QTHs are not required to have any training, but I high-



Our communications setup when we moved to Baton Rouge just prior to Hurricane Rita hitting.

ly recommend the courses offered by the ARRL. These courses will help you understand how operations are run today during an emergency. For those who want to work at the actual site, the more training you seek, the better prepared you will be. As for background checks, each person will have to cross that bridge and make his or her own decision when he or she comes to it. I personally have no problem with it, but I know that some do.

In summary, how we respond to emergencies has changed dramatically over the years. We hams need to embrace this change rather than battle it, because change will win most every time. Look at the sidebar and you can see how the MARS mission has evolved.

I believe that as technology continues to grow, we will see VHF playing an even greater role in disaster communications of the future—higher power, more repeaters, portable repeaters, and the list goes on. Let's be prepared to be a part of the team, as every emergency gives us an opportunity to learn how to improve.



Photo of an inlet on the Slidell, Louisiana side of Lake Pontchartrain. The surge came in from the ocean, and when the levees broke in New Orleans, the water sucked all of the buildings and items right into the lake.

VHF PROPAGATION

The Science of Predicting VHF-and-Above Radio Conditions

The Sun is Alive!

The last decade closed out with a welcomed sign that our nearest star was no longer inactive. From November 2009 until press time (early January 2010), sunspot activity ruled the solar disc. December was a very active month, with only 10 days without official sunspots. December 9 ended 16 days of zero spots that started at the end of moderately-active November. Sunspot region 1034 (as numbered by The National Oceanic and Atmospheric Administration, NOAA), small but belonging to the new Cycle 24, emerged near the eastern limb of the Sun. This small region resulted in an initial sunspot count on December 9 of 13. By December 12, it appeared to be fading, yet on December 13 it increased in spots with a count of 14.

Then on December 14 another new sunspot region numbered 1035 emerged, kicking the sunspot count up to 28. By December 15, its size was seven times wider than Earth! Over the next several days through December 18 this new Cycle 24 sunspot group rapidly increased in size, becoming one of the biggest yet in the new cycle. On December 16, the complex magnetic structures within this sunspot region triggered a coronal mass ejection (CME) toward Earth. This massively huge cloud of solar plasma (billions of tons!) arrived about three days later, but did not cause any geomagnetic disturbance.

Coronal mass ejections are the fuel for auroral activity, and that is welcomed activity to the VHF weak-signal DX hound. When active sunspot regions breed CMEs, the possible result is geomagnetic storms that counter any positive effect that the increased solar activity may have on radio signal propagation on the frequencies below 6 meters. At the same time, the CME unleashes a plasma cloud that rides the solar wind and then, if the unleashed ejection is directed into the orbital path of Earth, causes aurora. Auroral activity occurs at the *E*-region of the ionosphere, and “clouds” of highly-ionized clouds form that in turn may reflect radio signals in VHF and sometimes even UHF spectrum.

By December 19, the Sun kicked into high-gear with the total sunspot count climbing to 43, the highest yet in the new sunspot Cycle 24. This pushed the 10.7-cm flux up to 87 on December 17! While the increase in sunspot activity and the higher daily 10.7-cm flux (remaining in the mid-80s) are not yet high enough to energize the ionosphere for *F*-region VHF propagation, it signals an encouraging up-tick in sunspot cycle activity.

Speaking of size, the size of active sunspot regions is given as units, each unit being one millionth of the Sun's visible hemisphere (this unit does not have a specific name). The Active Region 1034 that emerged on December 9 measured ten of these units, or 10 millionths of the visible solar disc. By December 11, it grew to 20 millionths. With the new sunspot region, 1035, emerging on December 14, the total area of all active regions only totaled 30 millionths. However, 1035 quickly grew in size. By December 20, the total area of all sunspot regions equaled a huge 330 millionths of the visible Sun!

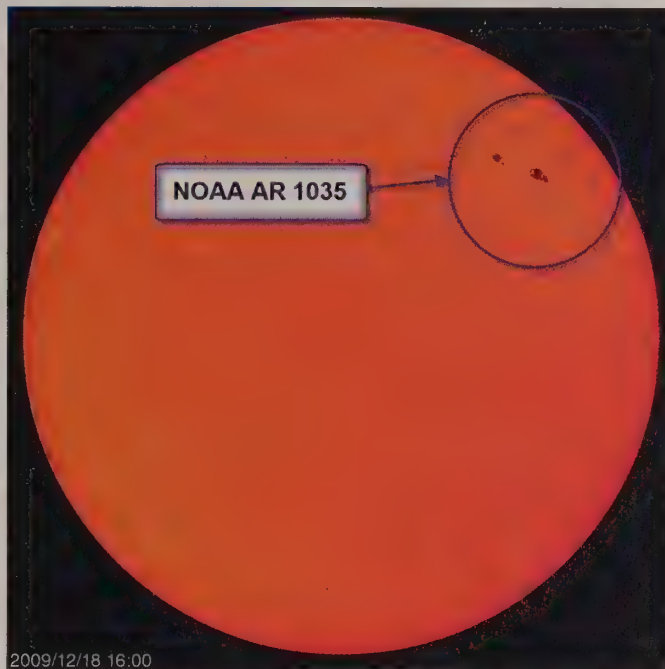


Figure 1. One of the largest active sunspot regions yet observed in the new sunspot Cycle 24, NOAA 1035, seen here in the Michelson Doppler Imager (MDI) intensitygram (IGR) on December 18, 2009. (Source: Solar and Heliospheric Observatory [SOHO])

By the New Year's Eve, three additional sunspot regions emerged—1036, 1037, and 1038. Region 1037 quickly ended, but the others continued to help keep things exciting. Additionally, Active Region 1039 emerged on December 27 and continued to rotate across the solar disc until it rotated around out of view on January 6, 2010. On January 7, region 1036 appeared to be rotating back into view! Perhaps now we can start to accept the idea that the new cycle is well under way. With that comes overall improvement on higher frequencies in the high-frequency shortwave spectrum. Soon, with this up-tick in sunspot activity the *F*-region of the ionosphere will begin to offer VHF propagation.

Propagation Outlook for February through April

Because of the nature of the Earth's orbit around our Sun, we have two seasons each year when any adverse space weather has a greater influence in causing geomagnetic disturbances: The first is known as the spring equinoctial season and the second is known as the autumnal equinoctial season. These are the two times during the course of the Earth's orbit around the Sun when the Earth is in just the right position to be most influenced by solar activity.

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e-mail: <nw7us@arrl.net>

The spring equinoctial season peaks between March and April of each year. Because we're in the very start of solar Cycle 24, it is likely that we will have significant geomagnetic disturbances this year, triggering the sort of auroral activity known to bring about VHF activity.

What is Aurora?

Aurora is a direct result of solar plasma interacting with gasses in the upper atmosphere. Aurora occurs during geomagnetic substorms. During these substorms, solar wind plasma resulting from coronal mass ejections can rain down into the atmosphere. Gasses in the atmosphere start to glow under the impact of these particles. Different gasses give out various colors. Think of a neon sign and how the plasma inside the glass tube, when excited, glows with a bright color. These precipitating particles mostly follow the magnetic field lines that run from Earth's magnetic poles and are concentrated in circular regions around the magnetic poles called "auroral ovals." These bands expand away from the poles during magnetic storms. The stronger the storm, the greater these ovals will expand. Sometimes they grow so large that people at middle latitudes, like California, can see these "Northern Lights."

Because the Earth's magnetic dipole axis is most closely aligned with the Sun's solar wind spiral in April and October, the interaction between the solar wind and the Earth's magnetosphere is greatest during these two seasons. This is why aurora is most likely to occur and strongest during the equinoctial months. When you see the solar wind speed increase to over 500 kilometers per second, and the B_z (one of the three dimensions of the interplanetary magnetic field) remains mostly negative (the IMF is oriented mostly southward), expect an increase in geomagnetic activity, as revealed by the planetary K_p -index (K_p).

This year, the spring equinoctial season will be active, with a few strong geomagnetic storms. If we do experience moderate to storm-level activity due to recurring coronal holes, look for aurora-mode propagation. The higher the K_p , the more likely you may see the visual aurora. However, you don't have to see them to hear their influence on propagation. Listen for stations from over the poles that sound raspy or fluttery. Look for VHF DX. Sometimes it will enhance a path at certain frequencies, while other times it will degrade the signals. Sometimes signals will fade quickly, and then come back with great strength. The reason for this is that the radio signal is being refracted off the more highly ionized areas in the E -region of the ionosphere that are energized by this aurora. These ionized areas ebb and flow, so the ability to refract changes, sometimes quickly. I've observed the effect of aurora and associated geomagnetic storminess even on lower HF frequencies.

Radio Aurora

If there are enough solar particles flowing down the Earth's magnetic field lines and colliding with atmospheric atoms and molecules, ionization occurs. This ionization may be sufficient to reflect VHF and lower UHF radio waves, generally between 25 and 500 MHz. This usually occurs in conjunction with visual aurora, but the mechanism is a bit different and it is possible to have one (visual or radio) without the other.

Using radio aurora, the chances of contacting stations over greater distances than would ordinarily be possible on the VHF frequencies is increased. Like its visual counterpart, radio aurora is very unpredictable. The thrill of the chase draws many VHF weak-signal DXers to working auroral DX.

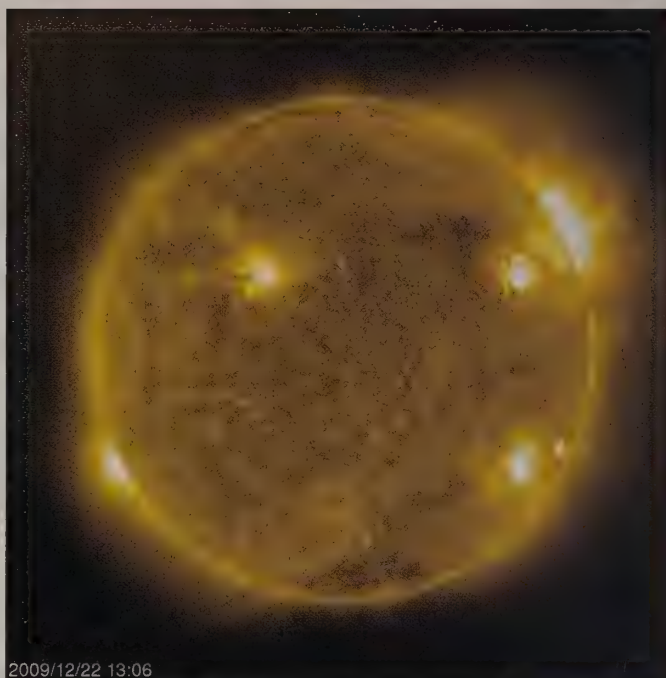


Figure 2. Look at all of the activity on December 22, 2009! At the end of 2009, the sun became very active with a combined active area larger than any previous active day since the end of solar Cycle 23. The 10.7-cm flux index rose to just shy of 90 during this period. (Source: SOHO)

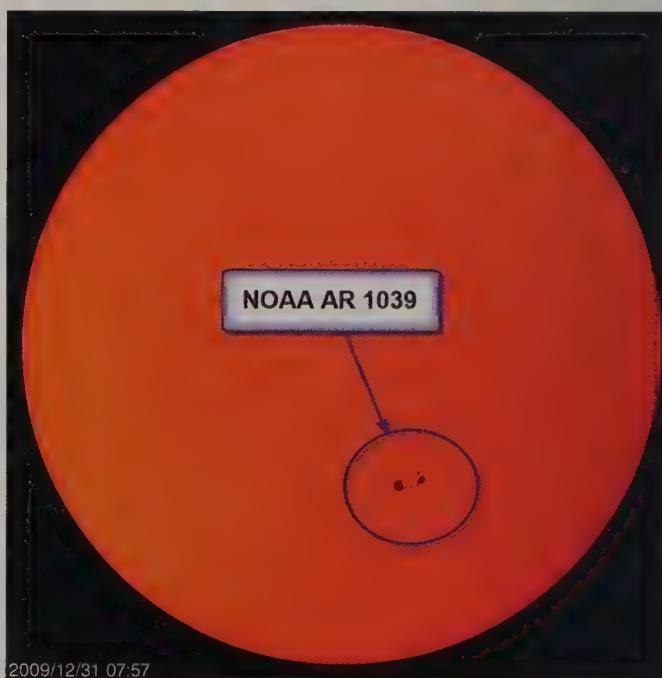


Figure 3. The intensitygram (MDI IGR) view of NOAA Active Region 1039 on the last day of 2009. This sunspot region did not fade away as it rotated away from view on January 6, 2010, but continued to produce minor flares. All of this activity during December, at the end of the second most "quiet" year of the solar minimum (2008 had more zero days than did 2009), indicates that the new solar cycle is alive and beginning to strengthen. (Source: SOHO)

VHF auroral echoes, or reflections, are most effective when the angle of incidence of the signal from the transmitter, with the geomagnetic field line, equals the angle of reflection from the field line to the receiver. Radio aurora is observed almost exclusively in a sector centered on magnetic north. The strength of signals reflected from the aurora is dependent on the wavelength when equivalent power levels are employed. Six-meter reflections can be expected to be much stronger than 2-meter reflections for the same transmitter output power. The polarization of the reflected signals is nearly the same as that of the transmitted signal.

The *K*-index is a good indicator of the expansion of the auroral oval and the possible intensity of the aurora. When the *K*-index is higher than 5, most readers in the northern states and in Canada can expect favorable aurora conditions. If the *K*-index reached 8 or 9, it is highly possible for radio aurora to be worked by stations as far south as California and Florida. Your magnetic latitude can be found using the map at <<http://www.sec.noaa.gov/Aurora/globeNW.html>>.

Meteors

While there are no major meteor showers during February and March, April has one meteor shower worthy of note. The *Lyrids* peaks on April 22 at 1700 UTC. While this shower peaks at about 18 meteors per hour, or about one per every five minutes on average, it can provide some good radio bursts. It is possible to see the hourly meteor rate (ZHR) reach as high as 90 per hour this year.

The debris expelled by comet Thatcher as it moves through its orbit causes the *Lyrids*. It is a long-period comet that visits the inner solar system every 415 years or so. Despite this long period, there is activity every year at this time, so it is theorized that the comet must have been visiting the solar system for quite a long time. Over this long period, the debris left with each pass into the inner solar system has been pretty evenly distributed along the path of its orbit.

This material isn't quite evenly distributed, however, as there have been some years with outbursts of higher than usual meteor activity. The most recent of these outbursts occurred in 1982, with others occurring in 1803, 1922, and 1945. These outbursts are unpredictable and one could even occur this year. The best time to work this shower should be from midnight to early morning.

The Solar Cycle Pulse

The observed sunspot numbers from October through December 2009 are 4.6, 4.2, and 10.6, showing a slow yet steady rise in the activity of the new sunspot cycle, Cycle 24. The smoothed sunspot counts for April through June 2009 are 2.2, 2.3, and 2.7. The smoothed numbers will likely show little improvement until the average covers the very last months of 2009, as the observed sunspot count for August 2009 is zero.

The monthly 10.7-cm (preliminary) numbers from October through December 2009 are 72.3, 73.6, and 76.8. The smoothed 10.7-cm radio flux numbers for April through June 2009 are 69.3, 69.7, and 70.2. As with the smoothed sunspot numbers, the smoothed flux numbers will show little improvement until they include the last months of 2009.

The smoothed planetary *A*-index (*A_p*) numbers from April through June 2009 are 4.3, 4.1, and 4.0. The monthly readings from October through December 2009 are 3, 3, and 1 (the most quiet this cycle). The overall geomagnetic conditions have been much quieter during the minimum period between solar Cycles 23 and 24 than the last few prior solar cycle minimums.

The monthly sunspot numbers forecast for February through April 2010 are 17, 20, and 23. The monthly 10.7 cm is predicted to be 78, 80, and 82 for the same period. That's really great news, as we'll likely see improvement in *F*-layer propagation higher and higher in the radio spectrum.

(Note that these are preliminary figures. Solar scientists make minor adjustments after publishing, by careful review.)

Feedback, Comments, Observations Solicited!

I am looking forward to hearing from you about your observations of VHF and UHF propagation. Please send your reports to me via e-mail, or drop me a letter about your VHF/UHF experiences (sporadic-E, meteor scatter?). I'll create summaries and share them with the readership. I look forward to hearing from you. You are also welcome to share your reports via my public forums at <<http://hfradio.org/forums/>>. Up-to-date propagation information is found at my propagation center: <<http://prop.hfradio.org/>>.

Until the next issue, happy weak-signal DXing.

73 de Tomas, NW7US

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Elmers: A Vital Part of Ham Radio Education

Last year was a very good year for the members of the Pueblo Magnet High School Amateur Radio Club. It was a year that saw new members, new licenses, new activities, and, most importantly, new Elmers. It was also a year that culminated in the creation of a ten-year design and development program to construct and launch a CubeSat satellite for digital amateur television and audio communications.

As a mathematics teacher and ARC sponsor, finding new projects and locating the resources to complete those projects is a constant challenge. Getting the students interested in doing the projects is the easy part of this endeavor. With the help of the ARRL's Education & Technology Program, the Pueblo ARC has a "patron saint" of sorts that provides wonderful possibilities to stimulate students' imagination and creativity. Building directional antennas to use in fox-hunting radio activities required one set of skills. Building a 5-watt QRP rig and getting it to work required a higher skill set. However, designing, developing, constructing, testing, and launching a CubeSat satellite will require skills that are far beyond the present level of Pueblo ARC members.

That is where Elmers become the critical part of this success formula. Since the Pueblo ARC began making presentations to parents, teachers, administrators, and ham radio club audiences informing them of the very ambitious CubeSat satellite program, many amateur radio operators have offered their assistance. The first to step up to the plate was Mark Spencer, WA8SME. Mark is the ARRL's Education and Technology Program Coordinator. Mark's support was the first datum that suggested our ambitious project is attainable. Larry Brown, W7LB,



One of the Elmers who has been supporting the Pueblo ARC for years is Ron Phillips, AE6QU, from the West Valley Amateur Radio Club in Sun City, Arizona.

was equally supportive and pledged whatever technical assistance he could provide. Jack McGowen, AD7NK, the newly elected president for the Green Valley Amateur Radio Club, was, and has been, equally supportive. Lloyd Miller, N7GV, also from the Green Valley Amateur Radio Club and our venerable technical problem solver, was quick to join the ranks of volunteers again.

These Elmers have been supporting the Pueblo ARC for years now along with Ron Phillips, AE6QU, from the West Valley Amateur Radio Club in Sun City, Arizona and Bruce Betterley, WA1BZQ, from the University of Arizona Amateur Radio Club.

Bob Frett, KE7YTF, is one of the newest Elmers to join the CubeSat satellite project. Bob was also responsible for getting his brother-in-law, William Creek, and his wife Elisha from Apache Junction, Arizona to donate an ICOM IC-718 to the Pueblo ARC. William and Elisha have not

been bitten by the ham radio bug but have made their contribution to the CubeSat program because they saw the value of their investment for the students, for the school, for the ham radio community, and for the U.S. Technically, the moniker "Elmer" would normally not apply to them, but we are making an exception.

Two additional new Elmers to the Pueblo ARC are Katherine Larson, KF7GFG, and Alex Thome, KF7GFF. Katherine and Alex obtained their licenses primarily so they can support our CubeSat project. Both of these Elmers attended the ARRL Teacher Institute I taught at Pueblo Magnet High School last summer and quickly committed to our ambitious goal. The ARRL Teacher Institute is designed to provide support for teachers at all levels with the primary objective of helping teachers use electronics and robotics in the classroom to effectively promote math and science literacy. Alex is currently completing his

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e-mail: <Miguel.Enriquez@tusd1.org>



Two new Elmers to the Pueblo ARC are Katherine Larson, KF7GFG, and Alex Thome, KF7GFF.

PhD in computational neuroscience. Katherine is a research scientist, teacher, poet, and novelist whose teaching method is as soft and loving as a mother's whisper in your ear.

Elmers become the vital part of any

ham radio community because they are truly the keepers of the flame. Without them and their expertise ham radio would regress to a "dark age" period. Nowhere in the books would our club have found the solution to fixing a Drake T-4XB, but

Kurt Cramer, W7QHD, knew exactly how to drop the transmitter six inches onto the table to get it working. You don't read that in the manual. His 40-plus years of enjoying the quality signal from his Drake rigs taught him that skill.

And so as the new decade begins, the Pueblo ARC students are focused on a long-term program of growth and development. As word of the CubeSat project spreads, other students want to join the Pueblo Amateur Radio Club. At a recent science night event held at Pueblo, two students and their parents attended just to inquire about getting permission to attend Pueblo High School because their middle school is not a feeder school.

I never had an Elmer, as such. However, my next-door neighbor, returning from the Air Force some 50 years ago, served as my unofficial Elmer. It was his demonstration of a CW contact with Bolivia that got me hooked. In a way, Sergeant Manuel Fierros became a better magician than Houdini when he allowed me to hear the symphony of dots and dashes via the wire-style headphones used in WW II. I still have those headphones. Until next time...

73 de Miguel, KD7RPP

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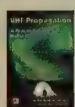


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DIGITAL RADIO

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Digital Frequency Coordination

Band plans have been present on the HF, VHF, and UHF bands for many decades. They were created to ensure that various modes and band uses didn't interfere with one another. Bands are regulated by the FCC, and it mandates band frequency usage by license class and/or mode. Band usage is also stipulated by ham organizations. National organizations such as the ARRL have created voluntary band plans to specify calling frequencies for each VHF/UHF band and designate band usage for segments of each band. Band plans can vary by geographical area to meet the specific needs of that area. Statewide and regional frequency-coordination organizations were created primarily to coordinate the frequency usage of FM repeaters in an orderly manner to ensure a minimum of interference among repeaters on the same frequency. Coordination organizations typically work with organizations in nearby states and areas to minimize interference.

On the HF bands there are recommended frequencies for the use of both digital data and voice modes such as RTTY, PSK-31, and WinDRM, etc.

Some History

During the 1970s and 1980s the number of 2-meter and 70-cm FM repeaters increased dramatically. In order to accommodate the need for more frequencies, many areas changed from 30-kHz channel spacing to 15-kHz pair spacing in the 146- and 147-MHz repeater sub-bands. Fifteen-kHz spaced repeater pairs were created between the 30-kHz pairs and used inverted receiver and transmit frequencies in order to minimize interference to existing 30-kHz spaced repeaters. When the 145-MHz repeater sub-band was opened, it typically was spaced at 20 kHz. In some areas the 146- and 147-MHz repeater sub-bands were respaced to 20 kHz as well.

In the early 1980s, when packet radio became popular on the VHF and UHF bands, band plans had to be modified to accommodate packet radio usage. The ARRL modified its national band plan and specified frequencies for packet radio usage.

Packet radio grew dramatically from the middle 1980s through the early 1990s. Most hams who used packet first set up their station on 2 meters on the typical calling frequency, 145.01 MHz. The frequency quickly became congested to the point of becoming unusable due to slow throughput on the frequency because of repetitive packet retries. Packet radio is a half-duplex mode. If a packet transmission isn't complete, the packet TNC will transmit again until it is successful. As usage grew, there wasn't enough time available on the calling frequency to handle all of the stations. Additionally, packet radio relies on all stations on a frequency to hear one another. If a station does hear others on the frequency, its transmissions could collide with them, causing packet retry transmissions and reducing throughput even further.

One of the solutions to frequency congestion was to create LAN (Local Area Network) frequencies for separate areas in a region to improve overall throughput. LAN frequencies were also designated to specific uses such as bulletin board systems (BBS), DX PacketCluster, and Keyboard-to-Keyboard.

Packet frequencies on 2 meters typically were in the 144.91–145.09 MHz range spaced every 20 kHz, like the repeater frequencies in the 145-MHz repeater sub-band. Packet radio also often used frequencies in the non-repeater sub-band from 145.51–145.79 MHz.

In some areas packet users put full-duplex packet FM repeaters on the air on the 2-meter and 70-cm bands. The purpose was not only to extend the range of packet stations, but more importantly to dramatically improve throughput by eliminating the hidden-transmitter effect caused by packet stations on a frequency not hearing one another.

Packet users also constructed high-speed backbone links to transmit data among BBSes. The backbone link frequencies often used the same bandwidth as analog FM, but sometimes they were wider when higher data speeds were used. The network backbone links on 70 cm often needed to be coordinated in order to not cause interference to other packet users and also to not interfere with repeaters and remote links. This required coordination with repeater coordinators who worked together, but often didn't publish, the frequencies of repeater system remote links.

The designation of LAN and networking frequencies needed coordination as well. In many areas the local repeater coordinator wasn't interested in coordinating packet frequencies because they do so for "repeaters." Consequently, packet radio frequency coordination typically became the responsibility of the local packet radio club.

When packet radio use began to decline in the late 1990s, the need for coordination became less necessary. In fact, in many areas packet radio clubs membership fell dramatically and in some cases the clubs disbanded due to lack of participation and interest.

Packet radio might have become completely unused had it not been for the development of APRS (Automatic Packet Reporting System) in the late 1990s. However, in many areas there has been a resurgence of packet activity, including many newer hams who had never used packet radio before. This increased usage will ultimately require hams on a local and regional basis to again coordinate usage of frequencies on a geographical basis.

Digital Voice Modes

Within the last few years, for the first time digital voice modes have started to be used on the HF and VHF/UHF bands. On VHF and UHF digital voice modes such as APCO P25 and D-STAR are the most common modes. P25 and D-STAR

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can be used simplex or with repeaters. Since these digital voice modes use repeaters, they need a pair of full-duplex frequencies and consequently need coordination from a local frequency coordinator. The challenge for a frequency coordinator has been where to place these new digital repeaters.

Although current P25 repeaters require only 12.5 kHz of bandwidth for digital voice, they often are implemented in dual-mode. In dual-mode a P25 repeater can receive and transmit either analog FM or P25 digital. While this approach preserves compatibility with legacy FM users, the repeater requires the same bandwidth as a traditional analog FM frequency coordination.

However, narrow-band modes such as D-STAR are only 6.25 kHz wide. Since at least two D-STAR repeaters could be placed in the spectrum that one analog FM repeater requires, it would be wasteful to coordinate a D-STAR repeater on the center frequency of an analog FM pair.

Repeater coordinators were faced with a decision of how and where to coordinate narrow-band repeaters such as D-STAR. In some areas reallocating separate frequencies to digital-only use was considered.

In California, where all repeater frequencies are often already coordinated and frequencies are not available, some repeater owners and coordinators designated D-STAR repeaters as not actually repeaters so they could place them in the 145.5–145.8 sub-band where repeaters were not allowed by FCC regulation. Some declared that the inherent delay in all digital transmissions meant they weren't simultaneous transmissions and therefore weren't repeaters. Others called D-STAR repeaters auxiliary stations. The FCC eventually declared that digital voice repeaters were repeaters and existing FCC regulations applied to them.

The Illinois Repeater Association (IRA) took a different approach to coordinating narrow-band repeaters. Their Digital Migration Guideline plan preserves compatibility with the existing band plan while conserving spectrum. This approach allows spectrum to be reallocated to narrow-band repeaters on the 2-meter and 70-cm bands as existing analog FM pairs become available. When an analog FM pair becomes available, the IRA plan can divide the FM repeater pair into up to three narrow-band 6.25-kHz wide channels. On the 30-kHz spaced, 70-cm band two narrow-band repeaters

could be placed at 6.25 kHz above and below the analog FM center frequency and potentially a third repeater on center frequency perhaps with some degree of geographic separation. Additionally, when adjacent FM frequencies become narrow-band as well as an inter-channel, narrow-band frequency could potentially be established. On 20 kHz and 15 kHz 2-meter bands the narrow-band repeaters are placed 5 kHz above and below center frequency. The IRA plan has been successfully implemented over the last 2½ years in Illinois. The plan has demonstrated that an existing analog FM pair can be used for two D-STAR repeaters in the same geographical area without causing interference to adjacent FM repeaters. More information about the IRA Digital

Migration Guideline can be found at: http://www.ilra.net/Documents/The%20Digital%20Migration-IRA_R0428071.pdf.

As analog FM repeaters and frequencies reserved for FM transition to narrow-band digital voice repeaters, there will be more repeater frequencies available in the same amount of spectrum currently used by FM repeaters. More importantly, digital-voice repeaters provide weak-signal performance enhancement over analog FM, and in the case of D-STAR provide data capabilities not available with FM.

I encourage everyone to explore the digital voice and data modes on HF and VHF/UHF, since they are the future of ham radio. 73, Mark, WB9QZB

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BEGINNER'S GUIDE

All you need to know but were afraid to ask . . .

SETI, EmComm, and YO-YO 72

Hello and welcome to 2010. I trust that Santa was good to you and this new year will be an informative and fun-filled time as we explore more of VHF+. As a starter for the new year, I plan on deviating a bit from the norm and wander into an exciting aspect that couples *real* QRP (low-power signals, 5 watts and under) with VHF+, resulting in an almost surreal endeavor: Searching for Extra Terrestrial Intelligence (SETI)!

SETI-101

One of the great things about living in northeast Pennsylvania for a number of years was I was close to Dr. Paul Shuch, N6TX, better known as “Dr. SETI” (*see his column elsewhere in this issue—ed.*). Paul is the firebrand behind the SETI League (<http://setileague.org/>), headquartered in New Jersey. I first became acquainted with Dr. Shuch about 10 years ago when I attended a York (PA) VHF club meeting where he was the guest speaker. The topic? SETI, of course!

Both my wife, Patricia, and I were transfixed by Paul’s presentation and joined The SETI League on the spot! His overall message: SETI is doable on a small budget, using cast off C-Band satellite TV dishes and some relatively inexpensive hardware, including the sound card on your computer. During his multimedia presentation, Dr. Shuch showed how easy it was to retrofit a 9- or 12-foot dish and achieve the sensitivity approaching (if not surpassing) the huge “Big Ear” radio telescope at Ohio State University. Wow! That is a lot to take in all at once!

The “WOW!” Signal

Speaking of “WOW!” the Big Ear radio telescope was the one that heard the famous “WOW!” signal in 1979. What was the “WOW!” signal? It was a series of coded observations recorded by a radio astronomer who was using the Big Ear at

the time. In the margin of the printout he placed the letters “WOW!” alongside the incoming signal. Was this the first indication of extraterrestrial life? The answer is unknown. Even though radio astronomers across the world followed up on the “WOW!” signal, no other emanations from that particular portion of the sky have ever been recorded. Try as they did, no one could duplicate the signal on other radio telescopes. Some think that this was an anomaly—some glitch in the receiving or recording equipment. Others think it might have been a terrestrial source such as an artificial Earth satellite or possibly a spy aircraft. In short, no one knows for sure. The “WOW!” signal still mystifies radio astronomers to this day.

SETI League and You

The ultimate goal of The SETI League is to use amateur radio astronomy equipment manned by SETI League members to provide an “all-sky” search in an attempt to receive some microwave transmissions from intelligent species outside our own planet. It seems far fetched, but in reality it is a starting point that, unfortunately, has been pushed aside by mainstream science and NASA. This leaves interested amateurs in the driver’s seat. With the current microwave receiving techniques coupled with re-tasked C-Band satellite TV dishes and some very sophisticated software, an individual can assemble a working radio telescope that would rival anything that could have been placed on line by universities and/or governments only 20 years ago. Now that is saying something.

The cost is quite economical, too, if I do say so myself. My 12-foot C-Band dish cost me absolutely nothing! It was free in exchange for my efforts to remove it. Thanks to Kyle Albritton, W4KDA, and his big pickup and trailer, we managed to dismount the dish from its mounting pole, load it on the trailer, and drive it about a half mile to my home. Two of my neighbors helped us man-handle the dish on and off the trailer. It now sits beside our house awaiting a new mount-

ing system and a whole bunch of concrete. All in good time.

Receiver Considerations

Believe it or not, procuring a dish was the easy part of this SETI station. The receiver was the biggie. If you have deep pockets, a wide-band commercial receiver such as the ICOM R-5000 would be a good choice. Why? It’s simple: The receiver tunes all the way up into the microwave region. This means no down-converter to worry about, and you can simply change out the LNA (low-noise amplifier) at the dish feed point with one that is cut for the hydrogen line (1420 MHz) or the hydroxyl line (1667 MHz) and run the signal directly in from the dish to the receiver. (*Note: The hydrogen line and the hydroxyl line are a band of radio frequencies between 1420 and 1667 MHz. This is a very quiet frequency spectrum where there is little noise from space. It is theorized that because of the quietness, the best possible SETI efforts can take place. The hydrogen line is the spectral line created by changes in the energy state of neutral hydrogen and occurs at a frequency of 1420.40575177 MHz. The hydroxyl absorption line is at approximately 1667 MHz.—ed.*) The output of the receiver is then routed to the station computer running the audio DSP software. Ergo, an “instant” (almost) SETI station.

If, however, you are like the majority of the rest of us, you are going to have to either make or buy an LNA with an LNB (down-converter) to place at the dish feed and run the down-converted RF signal into a VHF receiver (older 2-meter radios often are pressed into service here) and then take the audio output of the VHF receiver (henceforth referred to as a tunable IF) into your computer audio DSP software.

These extra steps escalate the overall cost of our new SETI station. However, it is an acceptable way to accomplish the end mission—to listen to the stars. Until recently, Down East Microwave, along with other gear manufacturers, has marketed LNBs that will work at the dish feed.

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Unfortunately, due to the lack of demand, these are no longer offered commercially, which means that you will either have to procure a used LNB or make one from plans in various ARRL publications or from internet sites. Either method is permissible and not all that difficult.

As my SETI station takes shape I will return to this theme and give updates as to how I conquered the various obstacles to get my station on the air. Although theoretically this is a “beginners” column, most of this SETI station is composed of commercial off-the-shelf equipment that is *not* beyond the capabilities of a newcomer to the hobby to duplicate. After all, think of the idea of engaging in the quest of a lifetime, trying to unravel one of the all-time mysteries of mankind: Are we alone in the universe? The idea that we, as radio amateurs, are able to participate in this ultimate quest is saying quite a lot about our technology and our skills.

EmComm

Emergency Communications (known also as EmComm) is of particular interest to me personally, and I feel that anyone new to the ham radio hobby needs to be thoroughly indoctrinated into the nuances of EmComm and why it is so important to the survival of our hobby. Having been involved with ham radio for nearly 50 years, I have watched our methods of communications evolve and expand into the exciting and ultra-cool systems we currently are using. When I first entered the hobby, AM (amplitude modulation) was “king” and SSB (single sideband) was just making inroads into HF communications. A few years later, AM signals were relegated to a narrow portion of the lower HF bands and SSB had come to dominate HF long-haul communications. In college we still used a lot of AM and CW on the VHF bands.

In the late 1960s the switch to FM was just starting, and to get a FM signal on 6 or 2 meters required the procurement and subsequent modification of a piece of used commercial FM gear such as a Motorola, GE, or RCA police and/or fire department radio. Once converted you had one or two channels of FM that allowed you to operate on a local repeater channel and one simplex channel (most likely the repeater output). As soon as the Japanese equipment manufacturers saw the huge potential market for 2-meter FM radios, the race was on. First with crystal-controlled gear, which was followed by synthesized gear that allowed full VHF/UHF band coverage.

Today we have excellent VHF+ FM rigs that offer built-in terminal node controllers (TNCs), Automatic Packet Reporting System (APRS) ready equipment, and now, with the advent of ICOM’s D-STAR software, we have digital voice/ data systems capable of operating on VHF+, which greatly enhances our capabilities as emergency communicators.

The FCC, as part of our licensing agreement, dictates that we, as ham radio operators, be available to lend a helping hand with emergency communications during times of natural and man-made disasters. Amateur radio is one of the very few “hobbies” that allows the participant to actively support his/her local community.

Since the atrocities of September 11, 2001, EmComm has become a buzz word across the spectrum of disaster preparedness. Professional disaster-preparedness mitigators have come to rely on trained amateur radio operators to augment, and in some cases completely replace, communications systems/facilities destroyed or impaired due to a crisis situation. The key word here is “trained.” The days of the ham radio operator showing up with a hand-held transceiver (HT) and a couple of battery packs to “furnish comm” are over. As the professionals

within the disaster-preparedness community quickly found out, many hams did not have the training or the developed skills and discipline needed to dovetail with the professional world.

To address those shortcomings, the ARRL, much to its credit, started offering continuing education courses in emergency communications (see <<http://www.arrl.org>>) with the hope that those amateur radio operators already involved with the Amateur Radio Emergency Service (ARES) and Radio Amateur Civil Emergency Service (RACES) would become involved and become fully trained EmComm volunteers.

Having taken all three levels of the ARRL’s EmComm courses, I can attest to the fact that the training is comprehensive, timely, thorough, and once trained, you are recognized as an EmComm volunteer who can be counted on to work within the disaster response community. In other words, you are “validated” and have become an asset to the professional disaster mitigators.

EmComm and You

Once you understand that you *must* become trained, get busy and get the training. Our local Gwinnett County (GA) ARES unit has a pre-deployment training program that *all* ARES members must complete prior to be allowed to participate in any ARES drills/real-world disaster events. Yes, they *do* take EmComm seriously here.

YO-YO 72!

Invariably, both new and experienced EmComm personnel start putting together their “Go-Bag,” or as I like to call it, “GOOD-Bag” (Get Out Of Dodge Bag). Unfortunately, all too often the Go-Bag becomes the primary focus of the EmComm volunteer’s life. ARRL ARES/RACES guidelines call for being self-sufficient for a 72-hour period, referred to as “YO-YO 72,” or “You’re On Your Own for 72 hours.”

In reality, I prefer to provision my GOOD-Bag for a minimum of two weeks, since you *really* don’t know what you might be getting into, and having the extra provisions, batteries, spare underwear, medications, bottled water, power-bar rations, etc., might mean the difference between being part of the solution to the disaster or part of the problem.

There is always the temptation to include as much radio gear as possible, along with a multitude of batteries, and everything up to and including the proverbial “kitchen sink.” Resist this temptation, *please!* First of all, the chances of needing a box car full of comm gear are virtually non-existent. You will mainly be concerned with VHF/UHF comms, so stick with that. A good, multi-band HT loaded with the necessary local FM repeater/simplex frequencies along with a hand-held scanner (to cover the local police/fire/EMS frequencies, NOAA WX radio) and an AM/FM commercial receiver to listen to the local news outlets will be all you really need to take along.

The ARRL ARES/RACES guidelines present a comprehensive list of things that your Go-Bag should have in it. Among the most important is to be sure that any maintenance medications that you might be on should be procured ahead of time with the help of your primary-care physician. Ditto on eyeglasses. Compare notes with other members of your ARES/RACES members to get an idea of what they have in their Go-Bags. You’d be surprised at what you might find.

Well, that is about it for this time. I will be revisiting this topic in the next installment of this column, so be prepared. Hmm . . . that sounds like the Boy Scouts! 73, Rich, K7SZ

UP IN THE AIR

New Heights for Amateur Radio

Launches by the Space Hardware Club of UAH

The Space Hardware Club of University of Alabama, Huntsville (UAH) has been flying a number of unique high-altitude balloon experiments. The club members meet two nights each week to work on their experiments and often launch a couple of balloons each semester. One of their payloads last year consisted of human and mouse nerve cells in an environmental chamber to see the effects of a trip into the stratosphere. The cells survived! UAH also flies Balloon-sats as part of the electrical engineering senior design class, but the Space Hardware Club (SHC) is unique in that students of any major can participate.

This past fall on a beautiful October day the SHC students launched a high-definition camcorder that also downlinked live video. The fast-scan amateur television (ATV) transmitter section (see photo 1) put out 3 watts on the 70-cm band into a

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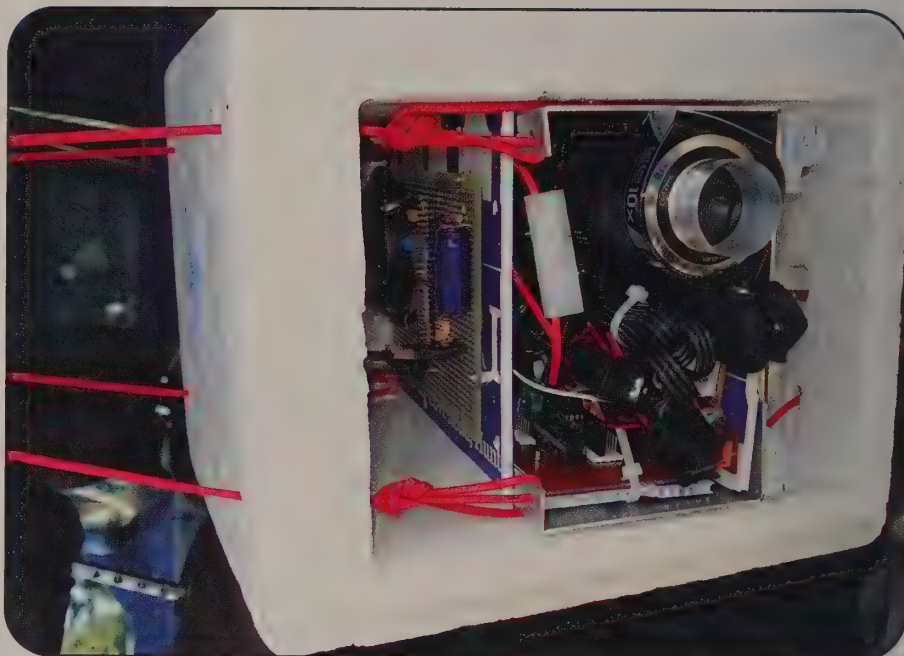


Photo 1. The Space Hardware Club's hi-definition ATV transmitter payload.
(All photos by Bill Brown, WB8ELK)



Photo 2. Club members get to wear this unique T-shirt.



Photo 3. The Space Hardware Club students prepare to launch their balloon experiments.



Photo 4. Barry Lankford, N4MSJ, sets up his portable ATV ground station.

horizontally polarized Little Wheel antenna. In addition, there were several APRS (Automatic Packet Reporting System) transmitters on 144.39 and 144.34 MHz for tracking the balloon's position during flight.

The calm winds allowed a picture-perfect liftoff (see photos 2 and 3) as the students watched their payload rise high above Huntsville, Alabama. Barry Lankford, N4MSJ, brought his portable ATV receiver and antenna to watch the video during the flight (see photo 4). In addition, the Electrical and Computer Engineering (ECE) department at UAH has allowed the Space Hardware Club to set up a great ground station in a room on the second floor that has roof access for their antenna system. The az/el rotor system combined with some custom programming of their ground-station computer allows the antenna to track the balloon by decoding the APRS downlinked position and altitude, calculating the azimuth and elevation bearings and automatically steering the antennas toward the balloon throughout the flight (photo 5).

This first flight of their ATV system had some antenna problems (the Little Wheel had been beaten up pretty badly during a number of earlier missions), so only a few minutes of live ATV signals were received. However, they did get some beautiful high-definition video recorded on the camcorder's memory card.

Jason, KG4WSV, did some repair work on the Little Wheel, and the club members flew the payload again a few weeks later from the Sparkman Middle School with excellent full-color live video received by many ATV stations across the southeast. I was able to receive that flight with nothing more than a 3-ele-



Photo 5. SHC students man the campus ground station.



Photo 6. Balloon ATV received by WB8ELK using an ICOM IC-R3 and handheld Arrow Antenna.

ment handheld Arrow Antenna hooked up to an ICOM IC-R3 radio in TV mode throughout the majority of the flight (photo 6). Hank, W4HTB, had color video reception from over 200 miles away in Bowling Green, Kentucky and also linked his received video onto the BATC's (British Amateur Television Club) streaming video website ([www. batc.tv](http://www.batc.tv)). The balloon burst at peak altitude was quite spectacular. We could clearly hear the balloon pop and were treated to the sound of the air rushing by the payload as it started its rapid descent in the near-vacuum of the edge of space.

The final portion of the parachute drop back to Earth was quite exciting and a bit nerve-wracking, as the payload came down only a few hundred feet from Alabama's equivalent of the Grand Canyon (Little River Canyon State Park). Fortunately, a cliff-hanging recovery was not needed, as the payload managed to land in a tree not far from a road near the edge of the canyon.

For more info and announcements of future flights from the Space Hardware Club, visit: <http://spacehardware.uah.edu>.

73, Bill, WB8ELK

DR. SETI'S STARSHIP

Searching For The Ultimate DX

Watching Terrestrial Television at Alpha Centauri

In our last column, we explored an attempt to beam the 2008 film *The Day the Earth Stood Still* to purported science-fiction fans at Alpha Centauri, our nearest stellar neighbor. We showed through link analysis that to watch the movie they would require an antenna on the order of 3200 km in diameter – roughly the size of a continent.

Although I refuse to rule out the possibility of advanced extraterrestrial beings engineering antennas (or arrays of antennas) of continental scale, there still remains the problem of pointing those immense antennas in our direction. Recall that the beamwidth of a parabolic antenna can be estimated from its diameter and operating wavelength. For the Centaurian antenna, that half-power beamwidth is on the order of:

$$\theta = \frac{\lambda}{D} = \frac{5.0 \times 10^{-2} \text{ m}}{3.2 \times 10^6 \text{ m}} = 16 \text{ nRad}$$

which is on the order of a *millionth* of a degree. One shudders to think how any civilization, no matter how advanced, could aim a whole continent to that level of accuracy, much less track a moving target from a moving object for the length of a two-hour movie. However, more significantly, one must ask: Why bother?

One would think that by comparison to the Centaurians' challenge of aiming an antenna of continental size, our problem on Earth, pointing our tiny 5.5-meter uplink antenna, would be trivial. Not so, because although our antenna's half-power beamwidth is a respectable half a degree, we are dealing with an n-body Newtonian motion problem over interstellar distances.

Consider first that we are aiming our antenna from the surface of a planet that is both spinning on its axis and orbiting its star. That star is, in turn, revolving

around the center of the Milky Way galaxy, as is the Alpha Centauri system. Our movie-going audience is ostensibly situated on the surface of a planet somewhere in that triple-star system. Unless it is tidally locked (not a happy circumstance for the emergence of life), that planet is doubtless rotating on its axis, and negotiating a complex orbital dance with respect to its *three* suns. Our own motion is known, or can at least be computed. Having not yet even detected our target planet, we can only guess as to its complex path over time.

"Over time" is our key here. Remember that when we look at Alpha Centauri in the southern sky, we are seeing not where it *is*, but rather where it *was* some 4^{1/4} years ago. Thus, when we transmit toward Alpha Centauri, our antenna must aim, and track, not where it *was* 4^{1/4} years ago, or even where it *is* today, but rather where it *will be* 4^{1/4} years hence.

True, our half-degree transmit beamwidth gives us some leeway. As our beam spreads out conically in interstellar space, there is a chance that we might get lucky and that part of our signal may end up intercepting its intended target. Then again, maybe not. It's not an easy matter for me, or the Deep Space Communications Network (DSCN), to calculate.

The foregoing calculations might well cast a pall over the whole SETI enterprise. How can we expect, one might wonder, to intercept incidental radiation from a distant civilization when our own broadcasts are most likely not detectable at even the nearest star, but for superhuman efforts and incredible antenna engineering?

The encouraging answer is that SETI science seeks not to watch movies (or, in fact, to demodulate intelligence of any kind) as much as to identify signals of clearly intelligent extraterrestrial origin, providing proof of existence of our cosmic companions. Let's think about how *The Day the Earth Stood Still* uplink might have provided proof of existence to our cosmic companions, over far

greater distances than Alpha Centauri.

First, and most obviously, while demodulating viewable FM video requires a reputed positive signal-to-noise ratio on the order of 10 dB, we can detect the presence of an artificial signal at unity SNR, or even less. Thus, dispensing with that assumed 10-dB detector threshold allows us to decrease our receive antenna size by a factor of three, or alternatively, to increase our detection range for the originally computed antenna also by a factor of three. However, it gets even better.

Significant increases in detectability are achieved in SETI receivers by integrating a received signal over time. The longer the time averaging, the more a signal rises out of the noise. Of course, modulation (that is, information content) is lost in the process, but if we are seeking proof of existence rather than video entertainment, this is hardly a factor. In the present example, by integrating our received signal for a mere three seconds, we add an additional 40 dB to our SNR. This would allow us to increase distance by a factor of 100, or decrease receive antenna size by a factor of 100, or some combination of the two.

Finally, although a 40-MHz channel allocation (34-MHz receiver bandwidth) is typical for analog satellite TV, there are many modulation modes that concentrate considerable power into a far narrower bandwidth. Since narrowing receiver bandwidth improves SNR, we might expect to detect these narrower signals over far greater distances, or with significantly smaller antennas. A 500-watt carrier, for example, contained within a 10-Hz bandwidth could easily be detected over interstellar distances by an antenna such as Arecibo in Puerto Rico, Earth's largest radio telescope, given about 100 seconds of integration time.

Given the above, one wonders over what distance video programming from the DSCN can realistically be received given Earth-level technology. It turns out that an Arecibo could recover clear video

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from this uplink out to a range of about 3-billion km. This figure represents the approximate distance between the Sun and Uranus at aphelion. Thus, an Arecibo Observatory on Uranus could, if properly aimed, be used to monitor Earth's satellite TV uplinks.

Bear in mind that the uplink facility used at DSCN initially was intended to relay FM video via a communications satellite parked in the Clarke orbital belt, a mere 38,000 km from Earth. This is a facility designed for relatively local communications. That it appears capable of interplanetary video relay is encouraging. It should not disappoint that its utility over interstellar distances seems suspect.

"Give me a lever long enough," wrote Archimedes more than two millennia ago, "and a fulcrum on which to place it, and I shall move the world."

"Give me an antenna large enough," wrote the Alpha Centaurians, "and a target at which to aim it, and I shall watch your world."

Their task in viewing *The Day the Earth Stood Still*, though not inconsistent with the laws of physics, is nonetheless daunting beyond belief.

73, Paul, N6TX

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- 2m/440 HT
- 5W Wide-band receive
- CTCSS/DCS Built-in
- Emergency Auto ID

Low Price!

\$20.
mfr coupon



VX-7R/VX-7R Black

50/2M/220/440 HT

- Wideband RX - 900 Memories
- 5W TX (300mw 220MHz)
- Li-Ion Battery
- Fully Submersible to 3 ft.
- Built-in CTCSS/DCS
- Internet WIRES compatible

Now available in Black!

VX-6R

2M/220/440HT

- wideband RX - 900 memories
- 5W 2/440, 1.5W 220 MHz TX
- Li-Ion Battery - EAI system
- Fully submersible to 3 ft.
- CW trainer built-in

NEW Low Price!

\$10.
mfr coupon



VX-8R

50/144/222/440 Handheld

- 5w (1W 222)
- Bluetooth optional
- waterproof/submersible 3 ft 30 mins
- GPS/APRS operation optional
- Li-Ion Hi-capacity battery
- wide band Rx

(NEW!)



FT-857D

Ultra compact HF, VHF, UHF

- 100w HF/6M, 50w 2M, 20w UHF
- DSP included • 32 color display
- 200 mems • Detachable front panel (YSK-857 required)

Call for Low Price!

FREE
YSK-857



FT-7900R 2M/440 Mobile

- 50w 2m, 45w on 440MHz
- Weather Alert
- 1000+ Mems
- WIRES Capability
- Wideband Receiver (Call Blocked)

Call Now For Your Low Price!

FREE
YSK-7800



FT-2000/FT2000D HF + 6M tcvr

- 100 W w/ auto tuner • built-in Power supply
- DSP filters / Voice memory recorder
- 200W (FT-2000D)
- 3 Band Parametric Mic EQ • 3 IF roofing filters

Call For Low Pricing!

\$80.
mfr coupon



FT-450AT HF + 6M TCVR

- 100W HF/6M • Auto Tuner built-in • DSP Built-in
- 500 Memories • DNR, IF Notch, IF Shift

Call Now For Special Pricing

\$80.
mfr coupon

(NEW!)

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VA residents add
sales tax. Prices,
specifications,
descriptions,
subject to change
without notice.

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HRO Home Page
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VX-8DR

A Devoted APRS® Users Version of the VX-8R Series

The optional GPS Antenna Unit FGPS-2 can be either directly attached to the radio using the microphone input jack or to the optional external microphone MH-74A7A.

• Shown with the optional FGPS-2 GPS Antenna and the optional CT-136 Adapter.

Key Additional APRS® Features of the VX-8DR include

- **SmartBeaconing™ Function:** When using APRS® for position tracking, the beacon timing is automatically adjusted to your traveling speed and location to plot a smoother trace to match your position and movement on a map.
- **The number of Station List memories has increased from 40 to 50.**
- **The number of APRS® Message memories has increased from 20 to 30.**
- **DIGI-PATH route indication function:** The APRS® Packet data includes Digipeater routing info.
- **Heads up compass display to the GPS Screen:** Your traveling direction is always toward the top of the display.
- **The Message received LED flashing rate is selectable.**

* SmartBeaconing™ from HamHUD Nichetronix

NEW

50/144/(222)*430 MHz
FM 5 W/AM 1 W(50 MHz) Triple Band Handheld

VX-8DR

*222 MHz: 1.5 W (USA version)

Actual size

Key Features of the original VX-8R include

- Full 5 watts FM 50/144/430 MHz – plus 1.5 watts on 222 MHz. 50 MHz AM included.
- Bluetooth® hands-free operation with the optional BU-1 and BH-1A or BH-2A.
- GPS unit and antenna optional with loads of features.
- APRS® 1200/9600 bps data communication (B band only).
- Submersible - meets IPX57 - 3 feet for minimum of 30 minutes.
- 7.4 V 1100 mAh Lithium Ion battery included. 1800 mAh LI Battery and 3 x AA battery cell case optional.
- Small size 2.36 x 3.74 x 0.92 inches.
- Simultaneous independent 2-signal dual receive function. Both V + V or U + U
- Weather receiving with Weather Alert.
- Barometric sensor included.
- Operate Amateur radio while receiving AM/FM broadcasting.
- Dot matrix LCD display provides up to 16 character Memory tags, High-resolution Spectrum Analyzer with ±50 channels indication, Wave monitoring of received/modulated signal.
- DCS and CTCSS ENC/DEC included.

* APRS® is a registered trademark of Bob Bruninga WB4APR.

The VX-8DR has not been approved by the FCC. This device may not be sold or leased, or offered for sale or lease, until FCC approval has been obtained.

Specifications subject to change without notice. Some accessories and/or options may be standard in some areas. Frequency coverage may differ in some countries. Check with your local Yaesu dealer for specific details.

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YAESU
Choice of the World's top DX'ers™

Vertex Standard
US Headquarters
10900 Walker Street
Cypress, CA 90630 (714)827-7600

The Totally New - Advanced Dual Band Mobile Radio

5.2" x 1.6" Large dot matrix (264 x 64 dots) LCD display

GPS / APRS® / Bluetooth® Features



NEW
144/(220)* /430 MHz 50 W
FM Dual Band Transceiver
FTM-350R

*220 MHz 1W (USA Version only)

Large Multifunction Dot Matrix LCD & Selectable 8 color Backlight

Separate Front Panel & Rugged Die-cast Chassis (Fan-less / 50 W Output)

Optional GPS Operation
(with FGPS-1 or FGPS-2, GPS Antenna unit attached)

Integrated High-Performance APRS® Operation with SmartBeaconing™

1000 Memory channels
Left and Right side 500 channels each

Includes 3 Speakers,
(Two Speakers are in Front Panel for AF Dual Function, AM or FM Stereo Broad-casts, and External Audio Input.)

Dual Monitor AF Function

Barometer included

1200 / 9600 bps Data Communication

Control Head Rear Panel



← New Suction Cup Mounting Bracket

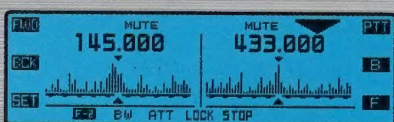
Rear Panel



FPR-1 Monitor Unit

Optional FPR-1 Monitor Unit receives your transmission out to about 1,000 ft (300 m) depending on transmit power and other conditions. Give to others to hear your transmissions during emergencies, special events, and so many other operations so that they can follow the situation.

Screen Example



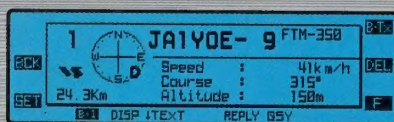
Dual Band (Spectrum Scope function)



Navigation (with GPS antenna unit attached)



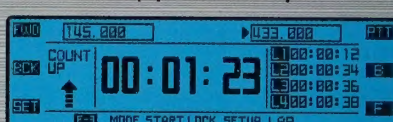
Mono Band (Spectrum Scope function)



APRS®



Barometer



Timer

The FTM-350R has not been approved by the FCC. This device may not be sold or leased, or offered for sale or lease, until FCC approval has been obtained.

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* SmartBeaconing™ from HamHUD Nichetronix

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